ANNUAL WATER QUALITY REPORT

Water Year 2002

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Preface to the 2002 Water Quality Report

As may be noted by readers of prior annual Water Quality Reports for the Sacramento District there has been a change of authorship this year. Victor Chan, author of prior year's reports, has transferred to the San Francisco District of the U.S. Army Corps of Engineers. This year's report is the product of John Headlee, P.E. and John J. Baum, both Environmental Engineers. With this change in authorship there are probable changes in perspective, Mr. Headlee having performed environmental engineering and water quality tasks in the context of navigational and construction dredging projects for several years and Mr. Baum having been in the Corps' rotational assignment program, but having recently received a Master of Science Degree in Environmental Engineering and formerly working in the field of limnology. Overall it is the hope of the authors that this perspective will be additive and that the reader will also find new perspectives and information in this work.

Some notable changes in this year's report include the manner of presentation of the metals data resulting from the water sampling program, the inclusion of more commentary on parameters other than just the metals, and a compilation of historic Secchi disk depths as a method of classification and lake health indicator.

The metals concentration data for the last five years had been presented as bar graphs at numerous different locations within any lake and at one downstream location. In the past the length of the bar was made to represent the either the "non-detect" concentration, a measure of the labs ability to measure, or the concentration if it were above the "non-detect" level. This is not representative of the concentration of metals within the lakes in the case of the non-detect value because a non-detect value means that there was no indication of the presence of the chemical. Representing a metal as being present at a concentration equal to the "non-detect" level is certainly conservative, but could lead to the indication of trends that do not exist in the instance where labs changed and the detection limit increased. Upon further enquiry it was found that the "non-detect" level was actually what should have been called the "practical quantitation limit" (PQL).for the lab, a level that is several to many times higher than the non-detect level so the past display of concentrations was doubly conservative and not representative of the state of knowledge concerning the water concentrations since the concentrations were not known, but certainly, if present, were below the plotted levels.

As a result of the discoveries above it was decided that as before where there were detections of metals above the PQL they would be plotted at the determined concentration, however, for levels below the PQL the unknown values would be plotted either as: 1) Their indicated value if a "flagged " value was presented by the lab indicating that even though there was no detection above the PQL, there were indications that the concentrations was "closing in from below" on the PQL value or 2) as a marker in the form of a very short yet visible bar to indicate that the metal was analyzed for, but it was either totally not found to present (non-detect) or that if there were indications that it might be present the concentration was indicated to be less than 50% of the PQL. The term "indicated" is used on purpose because as the concentration falls further and further below the PQL from the 50% level the probability that the quantity indicated is correct fades to insignificance.

The compilation of historical Secchi Disc depths (SD) was a first step toward using archived data to identify long-term trends within the lakes. Each lake has now been classified according to its historical average SD value and any newly acquired data can be interpreted more accurately.

I. Introduction

A. Requirements - This report follows the requirements of Engineering Regulation 1110-2-8154, entitled "Water Quality and Environmental Management for Corps Civil Works Projects". This USACE's regulation requires a summary of the water quality management programs for the past fiscal year, and requires the following items be addressed in this report:

(1) Description of the goals and objectives of the water quality management program.

(2) Progress made toward meeting those goals and objectives.

(3) Activities that are planned for out years.

(4) Changes in technical capabilities in the district office.

(5) Relationship between water quality and water control management activities.

(6) Pertinent division regulations.

(7) Laboratory facilities.

(8) Data management system.

(9) Training needs.

(10) A discussion of research and development needs.

(11) Special studies completed or required.

(12) Water quality coordination with other agencies.

(13) Scheduling for detailed project evaluations.

(14) Problems encountered with contracted work.

(15) Hindrances to meeting goals & objectives & proposed solutions

(16) Special assistance from other Corps elements or research facilities.

(17) A project-by-project summary of water quality conditions.

(18) Problems encountered and how addressed at each project.

(19) Opportunities identified and how addressed.

(20) Innovative techniques utilized to improve water quality.

(21) Regulatory changes

(22) Data or R&D activity with Corps wide applicablility

B. Goals and Objectives

The goals and objectives of the water quality management program are to ensure that the US Army Corps of Engineers' projects in the planning, design, construction, and operation phases do not degrade water quality and that the beneficial uses of the water near the project site can be maintained. As announced this year, this includes consideration of cumulative impacts and unintended consequences. Progress toward the goal is achieved by having a water quality engineer participating in the Civil Works Process beginning with the Reconnaissance phase all the way to the Construction phase. Critical involvement is in the intermediate phases when the feasibility studies and engineering work are being accomplished. A water quality engineer ensures that the Civil Work Process includes the application of monitoring programs, best management practices, the utilization of analytical techniques, and the installation of mitigation devices where needed.

Other goals and objectives for the existing 12 lakes in the annual lake monitoring program are to establish the baseline water quality conditions, to detect the entrance of undesirable nutrient and toxic loads, monitor for any adverse trends, and to ensure that the water quality remains satisfactory to support the beneficial uses assigned to the lake and the downstream water from the lake.

C. Progress Made Toward Meeting The Goals and Objectives

During a typical US Army Corps of Engineers project's planning phase, a water quality engineer will be involved in negotiating or reviewing the state regulatory requirements such as the Waste Discharge Requirements (WDR) issued by the applicable California Regional Water Quality Control Board. If the regulatory requirements have already been established, the water quality engineer would issue a written or verbal report evaluating the regulatory requirements and make recommendations to the Project Manager on specific steps necessary to ensure implementation and compliance. Some of these recommendations may include environmental engineering to ensure water quality. Prior to entering the construction phase of a project, the water quality engineer can work with project managers to ensure that storm water pollution prevention measures that are needed for a project have been anticipated. During construction the water quality engineer performs follow up to validate that the anticipated storm water pollution prevention measures are operating adequately and implemented properly. Additionally, during the construction phase of any in water work the water quality engineer verifies that adequate water sampling is performed.

Ecosystem restoration projects are becoming more common and more important in the future of US Army Corps of Engineers. This is somewhat of a shift from the original objective of protecting the environment. The new objective is now restoring the environment that has been degraded by prior human activities. Now the District's Planning Department solicits the views of a District water quality engineer to provide technical insight in the planning and design of ecosystem restoration projects during the reconnaissance and feasibility stages. An example of this is the Feasibility Study for the Steamboat Springs (Sparks, NV) restoration project which may have started with wetland creation as an objective, but was steered away from that objective to strictly riparian habitat creation because of the mercury content of the stream's waters and the potential for transformation of that mercury into a bio-available form by wetlands.

For the Lake Monitoring Program, the baseline data has been established so this program is progressing to address more site specific ecosystem problems such as MTBE and mercury in fish that have been found on certain lakes. Additionally, the baseline data collected is being compiled to more accurately look at long term heath trends within the lakes.

D. Activities Planned For The Out-years

All of current programs are expected to continue. The current plan for the existing annual lake water quality monitoring program is to start tailoring the program to address site-specific conditions. More monitoring may be performed on lakes that are experiencing problems while other lakes with no apparent problems will have a reduced monitoring program. The lake monitoring program is now focusing on the potential bioaccumulation of mercury in fish tissue and sample points where other lake parameters were higher than expected. Addtionally work will be done to incorporate archived data in order to observe long term trends in the lakes that may not be apparent when examined year to year.

The report for the data collected from the Sacramento Deep Water Ship Channel pre-deepening salinity monitoring program in the mid 1990's is going to be finished so that it is available for comparison to post-deepening data.

The jet aerators in the Stockton Deep Water Ship Channel (DWSC) are expected to continue to be utilized during the fall salmon run, but consideration is also being given to using the aerators at other times in mitigation for deepening near the berths of the Port's new "West Complex" previously known as Rough & Ready Island. During the year a ship collided with the dock that supported the walkway to the aerators, but left the aerators relatively unscathed. They have been restored and are operable.

Of course in the first instance the aerators were put in place in mitigation of the presumed oxygen demand created by deepening the Stockton DWSC from 30' to 35'. The Port of Stockton and portions of the DWSC have been declared an impaired body of water under § 303(d) of the Clean Water Act based on low levels of dissolved oxygen (DO). As a result a Total Maximum (oxygen load) Daily Load (TMDL) is in the process of being prepared for this reach. It has been found that any one of three factors , if eliminated, would resolve the DO impairment: 1) Flows below approximately 2000 cfs. 2) The existence of a deepened port and 3) Biologic loads from several sources including, those from upstream, those from the Stockton treatment plant and/or from Stockton stormwater. There have been occurrences of DO in the region of 1 mg/liter this year as compared to the desired 5 mg/liter. The eventual form of the TMDL will be more clear by July 2003 when it is due to be presented to the U.S. EPA. It is likely to include a so called phased approach in which immediate measures such as aeration are tried while the influence of other factors and other measures to be taken are being determined. In response to long standing requests, the Corps has become involved in this process.

A review of the last year's Water Quality Report reveals, from the perspective of one involved in the qualitative change in the WDR for navigational dredging that was wrought in that time frame, a light treatment of the subject. Some of the recent events mentioned below occurred slightly after FY 2002 ended and hence are treated here in the out year section, albeit the requirements below will express themselves within only the next few months during the 2003 summer dredging season. Beginning at the beginning; in 1999 the Central Valley Regional Water Quality Control Board (CVRWQCB) received Cal-Fed funding to completely overhaul the dredging WDR's. This task was undertaken with a vengeance. For the five months preceding the hearing on whether the new WDR should be imposed by the CVRWQCB over the Corps' objections, little other than commenting on the stringency of the WDR was done by the water quality engineer involved in navigational dredging. At the hearing on May 11, 2001 the CVRWQCB imposed the WDR as it was over the Corps' objection. A precautionary appeal was filed. The period for bringing the appeal runs this May 11, 2003. At the hearing CVRWCQB representatives stated on the record that in applying the WDR that both attenuation of contaminants and mixing with waters having sufficient assimilative capacity would be allowed. It was not until this reporting period (FY2002) that it became clear what the CVRWQCB's interpretation of such allowances were. Suffice it to say the Corps' now finds itself saddled with more restrictive requirements than it anticipated at the time the WDR was imposed with the possibility that no mixing being allowed in receiving waters for bio-accumulative metals such as mercury.

This is a potentially significant limitation since in high water years or in construction dredging it is necessary to discharge effluent at some sites and the concentration exceeds the current criterion of 50 parts-per-trillion imposed by the WDR. Thus some out-year activity, perhaps in FY 2003 will have to be undertaken to either get relief from this criterion or to mitigate its effects, that being the prevention of the discharge of effluent from dredging sites. The latter would entail either increasing the size of dredge ponds or dredging at very low rates, both of which would increase the unit costs of removing dredged material from channels.

Further during the Cal-Fed grant period mentioned above CVRWQCB produced a Delta Dredged Material Re-use Strategy (DDRS) which delves deeply into the area of restrictions on re-use of dredged materials. Re-use of dredged materials is beneficial to all concerned; it empties the dredged materials ponds so that they can be used again avoiding expense, it provides a benefit to the environment in providing a convenient source of material to build wetlands, in shore (barrier) islands, and to reduce the depth of flooded islands so that wetland habitat can be established. It has been used as reinforcement material for levees thereby lessening the probability of a levee failure that could draw saltwater into the delta. It has been used for fill and as sand for concrete and can be a source of revenue to either lessen the cost of dredging or benefit the construction of better waterways. It is planned to be used in Old Mormon Slough, an upstream branch near the Port of Stockton, for capping contaminated sediments off shore of a former wood treatment plant. Tests of the Corps' dredged materials show that it is freer of metals contamination than materials supplied by large scale materials operations and is, of course, convenient to transport to water related construction projects.

Even though the CVRWQCB expresses its own doubt about whether it has jurisdiction to regulate sediments, other than those that might have an impact on groundwater through leaching, it has propounded the DDRS in June 2002, and gave notice of the preparation of an Environmental Impact Report at the same time. The DDRS *per se* purports to deal only with dredging projects of under 100,000 cubic yards, yet the Corps has been told that it is the intent that some day a DDRS like instrument will become first a Regional Management Program Plan (RMPP) for dredged material and then after having gone through the approval process be written into the San Joaquin-Sacramento Basin Plans when it will become "law." The intent of the DDRS at the outset was to provide persons with a guidebook on how to get approval of smaller dredging projects. It evolved however into a document that places some restrictions on as much as 90+% of the re-use of dredged material. It is wondered if the DDRS might not have a restrictive effect on the beneficial re-use of dredge material, one that does not exist on materials that just happened to be obtained from a sand and gravel company instead of from a body of water. The restrictive effect of the DDRS results from its means of arriving at sediments standards, that being basically that five different sets of criteria were considered and the most stringent picked. Because the Corps does have dredging projects in the size range covered by the DDRS (e.g. Folsom Reservoir construction dredging) and because it is the announced objective of the CVRWQCB to eventually expand the reach of a DDRS like document to the Basin Plan which applies to everything, it would behoove the Corps to become involved in out years in the crafting of this document. To this point in time, much like with the navigational dredging WDR, the Corps' pleas for rational regulation have been unheard.

As referred to above TMDL's have become an issue for the Corps. For instance one of the remedies the CVRWQCB has mentioned to alleviate low DO at the Port of Stockton is to deny any dredging permits so that it will eventually fill back in making it more shallow and reducing the retention time in the port. This directly affects the Corps' mission of keeping the channel open. Thus, there may be out year activity on this subject, perhaps not just at the Port, but also in regard to water control as water quality and water control become more closely linked. The final implementing regulation for TMDL's is due in March 2003 so it is not yet known what form that regulation will take, but it is certain that the subject will not just "go away" and, therefore, there are likely to be out year activities associated with TMDL's.

Finally, also in March 2003, all construction sites one acre or more in size will have to obtain National Pollution Discharge Elimination System (NDPES) stormwater permits. Victor Chan before transferring set up a program and published a work instruction for obtaining such permits. What has been observed in the five months since Victor's transfer is that there is still some confusion about the applicability of the NPDES permits and the process for obtaining them. For example, questions have been received on whether a series of less five acre (old limit that required a permit) bank protection segments of a project which totaled more than five acres needed a permit (Yes.). Plans and Specifications for projects have been reviewed in which the contractor is required to prepare Storm Water Pollution Prevention Plan (SWPPP), but drops the subject at that point without requiring them to either file an Notice of Intent to do their grading or pay the fees. This will involve out year efforts to make sure these defects are cured and to instruct job inspectors regarding the basic tenet of a SWPPP which is a commitment on the part of the contractor to implement it in the field, make modifications if the measures in the SWPPP prove inadequate, keep records of changes, make an annual report stating that they are still following the plan and testing if there is a release of a non-visible pollutant

On a related note the reader is referred to the section below on required research and development which would occur in out years, but not necessarily that far in the future.

Two of the most notable out-year activities are the deepening of both the Stockton and Sacramento DWSC's. the Stockton DWSC was deepened in the 1980's from 30 to 35 feet and, as mentioned above, the Corps agreed to install aeration as mitigation for the worsening effect on DO at the Port of Stockton. Further the Sacramento DWSC began deepening in the mid 1990's but proceeded only nine miles from the Port out of a total of thirty some miles before being brought to a halt by funding issues. Of course the depth of the channels is a big issue because it significantly affects the amount of cargo that can be put aboard each vessel and hence the shipping cost, since the remainder of ship operation costs remain relatively fixed even with a bigger load. In December of 2001 both the Ports of Stockton and Sacramento asked the Sacramento District, District Engineer that their deepening projects be managed by the San Francisco District that had recent experience with two deepening projects for the Port of Oakland and otherwise had a more facilitative outlook regarding their projects. Both these projects are conducting modeling studies on the subject of any adverse salinity intrusion effects of deepening and in, addition, the Port of Stockton is considering the effects of deepening form 35 to 40 feet on DO. These efforts are at their beginning as affects the Sacramento District, but it is certain that there will be out year activities if not within the Sacramento District, at least within the geographic boundaries of the District concerning these two deepening projects.

E. Changes In Technical Capabilities In The District Office

As referred to in the preface to this report during the year Victor Chan transferred to the San Francisco District leaving a vacancy and reducing the water quality staff to one. Since that time, also as mentioned above, John J. Baum has been assigned to the open position and his participation in this report has been noted. It is anticipated that the vacant position will be filled in the next year. As was mentioned in last year's report District knowledge is expanding on ecosystem restoration and methly-mercury issues due to project experience and training. Newer employees, more recently graduated from universities that have curricula that include water quality courses are expected to maintain water quality technical capability. As more and more real time water quality data and information goes on line, the Internet is becoming an important source of information. The uploading of this Annual Water Quality Report on Sacramento District's web page also facilitates the sharing of water quality information. There has been an enquiry from U.C. Davis already as to when this year's report is due to be posted.

F. Relationship Between Water Quality And Water Control Management Activities

The Water Quality activity is located within Environmental Engineering Branch, while the Water Control Management activity is located within Civil Design Branch. Personal communications with the Water Control activity indicates that water control for the sake of water quality is not yet coming to the fore as far as the Corps is concerned because other than for purposes of flood control the Corps does not "own" the water and, therefore, makes whatever releases it makes other than during flood events, only at the behest of the "owners" of the water. Further Corps dams, other than Warm Springs Dam at Lake Sonoma, are not equipped with variable height shutters to regulate water withdrawal height and hence temperature. At Warm Springs there are shutters and the outflow from the dam is operated in such a way the temperature and DO are adequate for the rearing of the downstream fishery.

With the advent of TMDL's based on such water qualities as DO, it is expected that the linkage between water quality and water control (quantity) will become greater in the future. Temperature modifications are being made to more than one dam and the Corps has been advised that dam operators are being asked to consider releases to alleviate, for instance, the Stockton DO concern. Due to the lack of any control other than flood control it may be that the owners of the water in Corps dams are receiving such requests also, but may not be making it known to the Corps that called for releases are for water quality purposes.

G. Pertinent Division Regulations

There are no pertinent South Pacific Division Regulations at this time. As mentioned above Sacramento District published its NPDES work instruction on its web site. As in last year's report it is noted that previously unregulated Municipal Separate Storm Sewer Systems (MS4) located within urban areas will be regulated by the Phase II NPDES program by March 2003 which requires the development of a Stormwater Management Plan.

H. Laboratory Facilities

Private commercial laboratories are utilized to perform the lab analyses. The chemistry laboratory selected has to be State-certified in the parameters being analyzed. The current chemical laboratory is Cal-Test Lab located in Napa, California and this laboratory will be audited in 2003 by USACE personnel. An algalogist at the University of California at Davis does the biological analysis (phytoplankton) analyses. Multiple year laboratory and service contracts are now being set up to reduce the administrative effort involved in contracting.

In the navigational dredging program an error was detected by the Corps in the results pertaining to the 2001 Sacramento dredging. A supplement immediately correcting the error was sent to the CVRWQCB. The reason it is brought up in this year's report is that the last correction for the values was just received near the end of FY2002! This occurrence obviously gave rise to the subject of a Quality Assurance Program Plan (QAPP) for the civil works projects in general including dredging. The concern is that the errors in 2001 dredging resulted from human error and no plan has been yet devised that will prevent human error i.e. the error in question arose when a new instrument was not interfaced properly to the spreadsheet program that displays the results. It was found that the labs QA simply did not catch this problem. It was noticed when Corps' personnel noticed that metals concentrations went down when they should have gone up. The result was then examined by the lab and found to be incorrect, but the lab didn't catch it at all. The solution thus far has been to change laboratories and require electronic checking of electronically delivered results that will not allow one to ignore or miss, for instance, incorrect recovery percentages District staff continues to try to find a set of QAPP provisions that would have prevented the interfacing error. Various QAPP models are available including the recently completed SWAMP QAPP that will henceforth be used in State of California sampling and analysis projects.

I. Data Management System

Currently data is filed in files that are designated for either the water quality reports such as this report that contain mostly lake water quality data or for navigational dredging. Additionally for years up to 2000 the California Department of Fish and Game constructed a Microsoft Access database called DREDGE that contained all Sacramento results since about the late 1980's, sediment results of other agencies and for other projects and even a set or two of San Francisco District sediment data from near the district boundary at Antioch California. As above, analytical chemistry data is now being delivered electronically which might facilitate its being databased. Currently with the QA Level III packages being required of the labs, the papers associated with each DWSC exceed 500 pages each which before long will create a storage and access problem unless reduced to electronic form.

The Engineering Regulation cited at the outset states that the District must use automated information systems appropriate to its needs and that for public accessibility the EPA's national data storage and retrieval (STORET) system should be used. This has proved to be an elusive goal for not only this District, but for other agencies which all state, as we do, that some day the data should migrate to STORET. Frankly this writer has been so busy taking care of concerns brought about by the regulatory upheaval that this task has not been looked into other than finding out that there is and "old" and a "new" STORET that may not talk to each other. However from last year's report it is known that STORET training classes continue to be taught, therefore, the program must still be viable in one of its forms. It would be a shame for the DREDGE database to continue to fall out of date as it has for the last two years. Linking the database to a GIS display program, perhaps like Waterway's Experiment Station's DMSMART program that is an Oracle database linked to ArcView is a possibility. The overall objective is to accumulate enough dredging sediment data to demonstrate that it is not that variable from year to year thereby allowing dredging to proceed without being preceded by sampling, and analytical testing. In turn the objective of doing this is to speed up the time when dredging can be done so that the DWSC's will be at full depth for the maximum period of time before the dredging cycle begins all over again the next year.

J. Training Obtained

As was stated in the preface John J Baum is a recent graduate from the University of California at Davis with applicable course work in water quality and is therefore reasonably trained for the tasks at hand.

During this period John Headlee took courses in Dredging Fundamentals, Streambed Macroinvertebrate Surveys as an indicator of stream ecological health, a graduate level statistics course and continued to take courses in TMDL's and monitoring.

K. Training Needs

District personnel are obtaining the training as needed or learning on their own. Training includes environmental effects of dredging, water quality mathematical modeling of rivers and lakes, biology, and, as above, statistics. Funding is provided by either project funds (with project the manager's approval) or overhead funds (with branch head's approval). The latter is somewhat restricted this year with $200,000 being spread over 267 persons. One new program is a cooperative undertaking with the graduate school at California State University, Sacramento wherein Corps personnel are provided, tuition, books and transportation to take pertinent courses. This year courses in statistics, partitioning of contaminants between earth, water and air phases, geographical information systems (GIS) and water chemistry are being taken by Corp employees. Whether Corps employees will be partially compensated for their class time is currently being discussed.

There are several ecosystem restoration projects that are now in the reconnaissance and planning phase in Sacramento District and ecosystem restoration is expected to be a growing field. The interconnection of water quality, aquatic life, endangered land species, plant systems, and the general localized ecosystem requires more specialized training beyond water quality in order to ensure that the District's projects will be beneficial and cost effective. Fortunately a UC Berkeley Extension Certificate in Ecosystem Restoration is now available and participation in some of the courses is being considered. Due to the current budget constraints, it is likely that all the training that could be put to use now will have to be conducted over a 2 or 3 year period to spread out the cost. Other training needs are GIS and STORET, as previously discussed. Because of the watershed approach that is both current Corps policy and coming to the fore in such areas as TMDLS, GIS is also expected to be a growing field. Watershed programs frequently use geo-spatial information such as slopes and soils and crop types, therefore GIS becomes involved. The writer is attempting to learn the U.S. EPA program BASINS which is for watershed and surface water quality projections. It is programmed as an application of the ArcView GIS program. If self instruction does not work and TMDL's become an issue, formal training may have to be sought.

L. Research and Development Needs

As detailed in last year's report the District needs to know more about the process by which mercury is methylated (made bio-available) in wetlands. As mentioned above some projects located where mercury is present (much of northern California) are being modified to not incorporate wetlands because of the fear of methylating more mercury than the system that is currently in place. It was learned that a portion of one of Cal-Feds projects (Bear Creek) was halted for this reason.

Since as has been set forth above dredging may be restricted by the fact that mixing zones may no longer be allowed for persistent bio-accumulative contaminants it may become necessary to find a way to remove it from dredge effluent or, God forbid, after an emergency dredge project when mercury is found in the dredged materials. Last year's report suggested ionic separation and a presentation was had during the year for electrokinetic separation (even though Mercury is not a compound that ionizes). It is expected however, that if separation is required it will involve filtering or settling (perhaps by flocculation?) of suspended particles out of the dredge effluent, an expensive process which has unwanted consequences, i.e. the sludge would have to be disposed of or the dredge materials would be "jellified" and would not drain. In order to avoid this it is thought that perhaps the mercury criteria of

50 parts-per-trillion should be attacked because it is inappropriate. In this case it possible that an in-district analysis by our toxicologists of how the criterion was arrived at would perhaps indicate if there were anywhere to go with along this line.

Finally, there is an R&D need that is perhaps notable by having been overcome by events (OBE). For the longest time the District which had until now placed all of its dredged material “upland” i.e. out of the water had been waiting for the issuance of the “Upland Testing Manual” corresponding to the Inland and Open Ocean manuals. However in conversation with the operative parties at Waterways Experiment Station (WES) it has been learned that they intended to incorporate groundwater dilution in their dredge pond model an effect that the CVRWQCB has denied the District. The District had to go it alone with attenuation in the basement soils above the water table in an approach known as the cation exchange developed by the now departed Victor Chan. Given the increased stringency of the WDR it is likely however that either new methods for testing for leaching of metals out of dredged material or the presence/bio-availability of metals in dredge effluent will need to take place. The District has generally depended on outside agencies such as the US EPA , WES, the scientific community and universities which are better organized for R&D research. As above the web has become an important source of reference material and data.

M. Special Studies Completed or Required

Cation Exchange Attenuation - During this reporting period the District completed three studies of attenuation of metals in the basement materials under its dredge ponds. These studies were in the first instance required by the WDR and submitted when due exactly one year ago. After a long hiatus the district was contacted by the CVRWQCB and informed that it would not allowed to use attenuation in the soils laterally under the site to the receiving waters and that the water had to meet a special set of somewhat relaxed groundwater criteria not contained in the WDR, but in the DDRS before it ever reached grounwater. This required that the amount and character of the soils under each site be determined. Surprisingly there was from 10-13 feet of vadose zone and in places its was highly organic, the type of soil that has the highest cation exchange capacity. The above mentioned cation exchange capacity was then calculated and two supplemental reports were submitted showing that metals would be attenuated for the foreseeable future (one decade) by the soils under the ponds. It was not until the very end of this dredging season, actually just a bit into FY2003, that there were indications from the CVRWQCB that mixing zones for bio-accumulative metals might not be allowed.

As above, the Distirct is contemplating a literature search into the exact basis for the mercury criterion.

Bioaccumulation of Mercury - Results from United States Geological Survey (USGS) studies of fish mercury levels have increased public concern over contamination at Englebright Lake. Although USGS fish tissue concentrations were high enough to warrant additional monitoring (California Office of Environmental Health Hazard Assessment limit of 0.3 ppm), none of their results was above the FDA’s level of 1 ppm for a fish advisory. The USGS studies initiated a public news agency to test fish for mercury accumulation. Analysis of fish caught by the news agency resulted in a concentration of 1.2 ppm, which is above the FDA advisory limit. While the limited USACE fish tissue results have not indicated the need for a fish advisory, additional data is needed to verify the status of mercury in lake fish. Fish tissue analysis must focus on those species that are most likely to bioaccumulate mercury. An expanded fish monitoring program is recommended for Englebright Lake and all other lakes of concern.

Total Sediment Values - as is outlined in the reports for the individual lakes, Eastman Lake is currently displaying a three year trend toward higher and higher total sediment in the inflow and in the lake. An investigation of the circumstances of this trend is in order because of the potential effects on the lake.

N. Water Quality Coordination With Other Agencies

The District maintained contact with the following agencies on water quality-related projects: 1. CalFed At times there is a Corps employee that is detailed to this organization. 2. [San Joaquin/Sacramento] Delta Protection Commission, this is the organization under whose auspices the DDRS was produced by Cal-Fed and the California Department of Fish & Game. 3. U.S. Bureau of Reclamation, for the Folsom Dam modifications. The Bureau has operational control of Folsom Dam and Reservoir and wanted to be assured that water quality was being preserved during the construction of this project. 4. CVRWQCB this is the state agency which grants dredging permits and imposes conditions on them ans which is snow in charge of the Port of Stockton DO TMDL. 5. Moss Landing Marine Laboratory, a state funded laboratory that is doing a good deal of work in mercury and put on a seminar on methylation and supplied mercury data in the delta. 6. U.S.G.S. through its facility on the California State University Sacramento campus provided information concerning the efficacy of one dimensional models for determining probable salinity levels in the DWSC's after deepening and would likely weigh in with its circulations studies in Suisun Bay which is just downstream of the deepening projects. 7. California Water Environmental Modeling Forum (nee Bay-Delta Modeling Forum), provides workshops on various topics having to do with models and water quality and convenes an annual meeting and seminar that deals with water quality related topics. 8. Lahontan Regional Water Quality Board concerning the Lake Tahoe Restoration Project of which there will be more mention later. 9. Naval Weapons Station Concord, there was contact concerning phase I characterization of some of their sites. 10. US. EPA Region IX & DMMO (Dredge Material Management Office) both concerning the roll out of Long Term Management Strategy for sediments in the SF Bay area and (Reg. I) briefly concerning the DDRS. 11 National Parks Services (Department of Interior) – concerning NPDES stormwater permits.

O. Scheduling For Detailed Project Evaluations

Every year there is a dredging season that begins with condition soundings taking place at the beginning of April. Dredging generally takes place in a window that is from July 1 to November 30th. The Sacramento Deepening Project wants to conduct sediment sampling during roughly this same time period. The construction dredging for Folsom Mods is now proposed to happen during the summer months of calendar year 2003. Any appeal of the WDR would have to take place before May 11, 2003.

P. Problems Encountered With Contracted Work

As mentioned above a lab produced incorrect results for the Sacramento DWSC. The solution was to immediately correct the results given to the CVRWQCB. Another lab was retained to do the analysis work this year.

Q. Special Assistance From Other Corps Elements Or Research Facilities

Assistance has been obtained from Waterways Experiment Station on dredging activities.

R. Project-By-Project Summary of Water Quality Conditions

As in last year's report the lake water quality is commented in section II

S. Problems Encountered And How Addressed At Each Project

As indicate in last year's report compliance with ever more stringent regulation of dredged material and stormwater is causing changes. Thus far the challenges have been met by more careful analysis of effects such as the reports for attenuation of metals mentioned above. Stormwater regulations are being met by the publication of the Stormwater Work Instruction and compliance with SWPPP's. The result of more stringent regulation is higher unit costs for excavation to include dredging and also lesser impacts on the environment. The District's water quality engineers are becoming more involved in projects as water quality concerns become more of a driver.

The goal announced last year of publishing the sediment analysis results has not been attained at the Corps although prior years data have been put in the DREDGE database by the California Department of Fish & Game. Several enquiries have been made about potential host for the DREDGE database, but none are known to have accepted this challenge.

T. Opportunities Identified And How Addressed

During this year there has been outreach to the National Park Services (NPS) and the Naval Weapons Station, Concord. The Station's Commander has requested technical assistance from Sacramento District due to the limited technical staff in Concord. Both the Corps and the customer organizations would benefit because this would expand work at Sacramento District while the smaller federal facilities would avoid hiring and training new employees. In order for this benefit to occur, it would be necessary to either shift district staff assignments or fill the position left vacant by the transfer of the primary proponent of this work.

U. Innovative Techniques Utilized to Improve Water Quality

Two innovative techniques are currently being utilized by the District, as follows:

<u>Jet Aeration System</u> - Sixteen jet aeration nozzles mounted on two underwater manifolds are continuing to be utilized to input dissolved oxygen into the San Joaquin River at the Port of Stockton during the fall salmon run. At the recent National TMDL Science and Policy Conference, the firm hired by the Savannah District mentioned the fact that Sacramento District's aerator was the only aerator application employed to mitigate for dredging that they were aware of. Further they are considering this as mitigation for the Savannah Deepening Project. The consultant for the Port of Stockton has conducted tests of pure oxygen injection for this purpose and it is understood that the Port is interested in operating the aerator installed by the Corps for longer periods of time also for mitigation.

<u>Cation Exchange Attenuation</u> – Acceptance this year of cation exchange as a means of showing leached metal attenuation in the soils beneath the dredging ponds by the CVRWQCB is, if not a first, certainly new to this District. This suggests that when the user designated attenuation factor is put into the spreadsheet referred to in the Upland Testing Manual[1], one manner of determining attenuation would be using the cation-exchange-capacity (CEC) that is determined by a suitable laboratory such as an agricultural fertility lab or golf course lab. If this is done care should be exercised that cation exchange is not also accounted for in arriving at partitioning coefficients.

[1] Technical report ERDC/ELK TR-03-1, *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual*, U.S. Army Corps of Engineers Engineering Research & Development Center (ERDC), January 2003. Spreadsheet referred to at p.6-9, § 6.3.1.

V. Action Items for the Lake Monitoring Program for 2003.

Feedback from the Park Rangers will be requested to determine if there are any site specific water quality issues that should be addressed in future Lake Monitoring Reports. A Field Sampling Plan and a Quality Assurance Project Plan need to be developed. The Quality Assurance Project Plan will address the need for field blind duplicates. Fish tissue analyses will continue for several lakes, to check for mercury content. MTBE monitoring will also continue for several lakes.

W. Regulatory Changes

Much has already been said above about the regulatory changes in the areas of upland dredged material placement and stormwater permitting. At this time the germ of the new regulations has been planted and, with time, it is an announced objective that these standards become part of the "law" of water, the Basin Plan. Since the criteria in these ideas will affect the re-use of dredged material and the degree to which environmental and commercial good can be made of these materials it behooves the District to be engaged with the process of rule making.

Although the degree to which water control (quantity) and water quality currently have merged is not particularly within this writer's ken at this time it is suspected that there will be a further movement in that direction. This has already surfaced as is indicated by the fact that the U. S. Bureau of Reclamation is being asked to consider additional releases at a point far upstream because that seems to clear the DO deficit at the Port of Stockton, California. This same concern is the subject of a TMDL which may well give rise to allocations by mid 2003. More and more impairing constituents are being identified , e.g. pathogens or "unknown toxicity" which inevitably give rise to TMDL's and allocations. All of these challenges will be expressing themselves as the practice of water quality management evolves. One of the aspects of this evolution will be thinking and analysis at a watershed scale and stakeholder group solutions to these concerns.

X. Data or R&D Activity with Corps Wide Applicability

Although strictly within the area of applied science, the Sacramento District's technique of calculating cation exchange capacity in relation to attenuation of metals in soils might be useful in other districts where regulators do not allow dilution of metals with groundwater or even in those where they do, but it is difficult to meet the surface water criteria once the leachate has traveled that far. This is in the context of any impoundment where relatively contaminated water is stored and ground or surface waters are to be protected.

Another effort that is under development is the production of a sediments database in Microsoft Access. Applications of the data themselves is not apparent to this writer, but perhaps the database architecture might be.

II. Projects in the Planning, Design, and Construction Phases

In recognition of the fact that most if not all Corps projects that deal with water side construction have an effect on water quality, a selection of projects and their effect on water quality is setforth at this point. This selection is by no means exhaustive and was based more on ready access to the information than any other factor.

Napa River
Flood Project
Napa, CA

Completed the first phase of a petroleum contaminated soil cleanup project as part of the overall flood protection project. Sheetpiles were used to contain and allow the excavation of petroleum products that would have leaked into the river. A silt curtain and oil sorbing buoys were placed in the water to contain any impacts from in water work. Tidally timed sampling was performed throughout the project. The second phase of the contaminated soil cleanup project will begin in spring 2003.

Cherokee Canal
Oroville, CA

Completed sediment budget and transport study in preparation for feasibility study and possibly design of low drop grade control structures in order to match sediment transport of upstream portions of stream to downstream canal portions thereby avoiding accumulations of tens of thousands of cubic yards of sediment yearly. Source water of stream is partly in area of historic gold mining with potential for involvement of mercury.

Galindo Creek
Walnut Creek, CA

Placement of a retention basin for peak flood flow alleviation. Importance to water quality is in leveling off all but strongest flows thereby affecting sediment transport.

Lake Natoma
Restoration of
Backwater
Folsom CA

Reconnaissance study of portions of a creek that is tributary to Lake Natoma, a manmade regulation lake downstream of Folsom Dam and Lake Folsom. Unfortunate flow restriction by culverts under major freeway have given rise to backwater in which nitrogen fixing algae *Nostoc* flourished after removal of water hyacinth by sponsor. Restoring freer water interchange between lake and backwater and creating condition calculated to inhibit the methylation of mercury from local gold dredge tailings through which creek flows are water quality effects.

Glenn–Colusa Irrigation District
Montgomery Island
River Mile 205.5
Glenn-Tehama County Line
3mi. NW of Hamilton City, CA

The recently completed gradient control structure on the Sacramento River had left areas that were previously riparian habitat that had been disturbed by construction activities. In addition there was the potential for erosion from the freshly graded shore side portion of the construction site into the Sacramento River. This project placed soil onto and infiltrating into the rockwork, then covered it with gravel to cobble sized rocks to lessen stormwater erosion and planted willow cuttings on the area in order to both restore the riparian habitat and stabilize the soil.

Upper Jordan River
Aquatic ecosystem restoration
Salt Lake City County, UT

By installing a benched bank, amongst other alternatives, this project would promote riparian natural habitat and tree over hang thereby reducing water temperatures and sediment loads which will promote higher dissolved oxygen levels. Other benefits of controlling sediment transport by bank protection and channel depth control structures are increased macroenvertebrate populations capable of supporting larger fish populations.

Capping Bottom of Old Mormon Slough
McCormick Baxter Superfund Site
Dredged Material Re-use
City of Stockton CA

Capping of sediments found to be a human health risk on the bottom of Old Mormon Slough is planned for the summer of 2003. Placement of approximately 43,000 C. Y. of dredged material from the Corps' Rio Vista, California Dredged Material Confinement Area in a two foot deep layer will prevent exposure. The dredged material is highly inorganic (98% sand) and was found to compare favorably to other commercially available materials with the additional advantage of being transportable by water to the site. For the present a berm is being built around the land-side exposure of the McCormick-Baxter superfund site to Old Mormon Slough and the banks have been stabilized with rip-rap to prevent re-contamination from the land-side. McCormick-Baxter was a former wood preserving concern located in the City of Stockton, California in the vicinity of the Port of Stockton.

Lake Tahoe
Restoration

The lake's clarity, as measured by Secchi disk depths, has been declining by one foot per year for the past 30 years. Far back in time there was almost complete logging of the slopes at the lake. More recently there has been development, increased numbers of visitors and the conversion of a wetland to a marina. These occurrences affect the nutrient load on the lake giving rise to the growth of algae which lessens the lake's clarity. In 1997 President Clinton and Vice President Gore visited the lake and set in motion a Lake Tahoe Federal Interagency Partnership to address water clarity. As last year's report indicated the Corps was to become involved in this initiative. The Corps is now working or has completed four tasks: 1) Analysis of groundwater as a source of nitrogen and phosphorus nutrients. Available data will be used in a model to determine groundwater/surface water interchange then remedial measures will be developed to reduce nutrient loading. This study is currently underway and will be completed in the summer of 2003. 2) Sewer line risk evaluation. A tool kit of Best Management Practices (BMP's) will be developed that will reduce the risk of the release of nutrients and other pollutants from wastewater facilities around Lake Tahoe. The draft of this report is currently being reviewed and concludes that less than 1% of the nutrient loading is due to sewer line exfiltration. 3) A small study was made of the state of urban stormwater management in the Lake Tahoe Basin. This task has been completed. The report concluded that there was no comprehensive stormwater plan for the Lake Tahoe Basin. Recommendations were made for tasks to be done to prepare a such a plan. 4) A statistical and site analysis of Tahoe Basin stream erosion will be conducted the result of which will be numbers for the erosive contribution of sediments to the lake. This study will be completed in the summer of 2003.

III. Annual Lake Water Quality Monitoring Program

A. Parameters Being Monitored - The District samples the 12 lakes in two sampling events, spring and late summer. The spring monitoring reflects the lake condition after it has received the bulk of the incoming nutrients, organic loads, and other contaminants that may have washed off of the watershed. Spring monitoring is done to examine lake dynamics prior to the arrival of warm summer conditions. The summer monitoring reflects the impact of warm weather conditions on the lakes. Some of the changes created by summer weather conditions are low dissolved oxygen levels that limit fish survival, undesirable phytoplankton blooms, accelerated organic decay toward the lake's bottom, shifts in lake pH, and increased impacts from recreational use.

B. **QA/QC Techniques** - The District is in the process of incorporating more QA/QC techniques into the annual lake monitoring program, so that the methodology is comparable to the USGS's NAWQS program or California's SWAMP program. This will then allow a multitude of agencies to share their data in the future with a feeling of confidence in support of better decisions affecting water quality. QA/QC techniques are built around a Field Sampling Plan and a Quality Assurance Project Plan. The primary analytical laboratory for lake water quality is Cal Test located in Napa California. A formal audit on this laboratory will be conducted by US Army Corps personnel in

2003 to verify compliance with the QA/QC requirements of the state of California certification program.

Field Sampling Plan - The U.S. Bureau of Reclamation does the field sampling for the District. In their work they follow several protocols on field sampling, as follows:

(a) USGS Field Guide for Collecting Stream Quality Samples. This consists of a USGS ring binder entitled "Guide for Collection, Treatment, and Analysis of Water Samples, Western Region Field Manual, Sept. 1990.

(b) California DWR, State Water Project Water Quality Field Manual, 1991

(c) USEPA sampling protocols

The District is currently starting work on developing their own QAPP which will incorporate the above by references but also take into account special needs of the District's program, such as the phytoplankton sampling program and field calibration techniques.

C. Changes for the Lake Monitoring Report for 2002

Historically, each water quality report was compared with the year or two preceding it as a reference for trends and overall lake health. This year Secchi disc depth data was compiled for thirty years in order to look for long-term trends. Additionally, the concentration of metals in lake water samples is now displayed showing additional historical values. Compiling, integrating, and analyzing the historical data for trends is an ongoing process that will continue over the next year.

The format of the 2002 Lake Monitoring report has changed slightly in order to reflect its more historic perspective. This year each lake's report will include a description of the lake and restate concerns from the previous years water quality report in addition to the standard information provided.

D. **Lake Annual Water Quality Reports for 2002** - The following lakes have had reports written for them. These reports only contain the highlights or summaries of the complete laboratory analytical results and raw field data. The complete report for each lake is available on the web and contains such additional information as tabular results and graphs. For any questions not addressed in the reports, please contact John Baum at John.J.Baum@usace.army.mil.

1. Black Butte Lake
2. Eastman Lake
3. Englebright Lake
4. Hensley Lake
5. Isabella Lake
6. Kaweah Lake
7. Martis Creek Lake
8. Mendocino Lake
9. New Hogan Lake
10. Pine Flat Lake
11. Sonoma Lake
12. Success Lake

Annual Water Quality Report

BLACK BUTTE LAKE

Water Year 2002

Written by
John J. Baum
Water Quality Engineer
U. S. Army Corps of Engineers
Sacramento District
January 2003

TABLE OF CONTENTS

Black Butte Lake

I. Purpose

This report is part of an environmental monitoring program that began at Black Butte Lake in September 1973. The monitoring program was implemented to determine water quality in the lake for both recreation and environmental health. This report was written to satisfy Department of Army Engineering Regulation 1110-2-8154, “Water Quality and Environmental Management for Corps Civil Works Projects”.

II. Brief Description of Black Butte Lake

Black Butte Lake was formed in 1963 upon the completion of Black Butte Dam. Black Butte Lake is located west of Orland, California on Stony Creek. It is an inviting and accessible recreation area on the west side of the Sacramento Valley. When full the lake has a surface area of 4,460 acres, is seven miles long, and has a shoreline of 40 miles. The dam provides flood damage protection for local towns and agricultural lands as well as recreation for the general public.

Generally there are two sample events each year, spring (April) and late summer (August). Since the start of the monitoring program, a water quality report has been produced yearly to list results and address any concerns of the previous water year.

Historically Black Butte Lake has a depth of < 100 ft, and is considered a hyper-eutrophic (very nutrient rich) lake when characterized by its clarity. One of the common characteristics of a hyper-eutrophic lake such as Black Butte Lake is that during warm late summer months the lower depths are extremely low in dissolved oxygen (DO). Additionally Black Butte Lake is warm (>20°C) in the late summer. Due to both the low DO concentrations and high temperatures, warmwater fish species are well suited to survive in the lake. Warmwater fish species include bass, carp, perch, bluegill, crappie, and catfish. Another characteristic of eutrophic (nutrient rich) lakes is their low water clarity due to algal blooms. A further characteristic of shallow lakes are sediments suspended by wind action which is another impediment to water clarity. Water clarity is often measured in terms of Secchi Disc depth or SD (Glossary, Appendix A). Historically the water clarity in Black Butte Lake has been low with ~37 % of the samples not meeting the recreational goal of 4 feet or greater (Figure 1.). In 2001 the Spring SD measure was below 4 ft (SD = 3 ft) and the late summer sample was clearer (SD = 6.58).

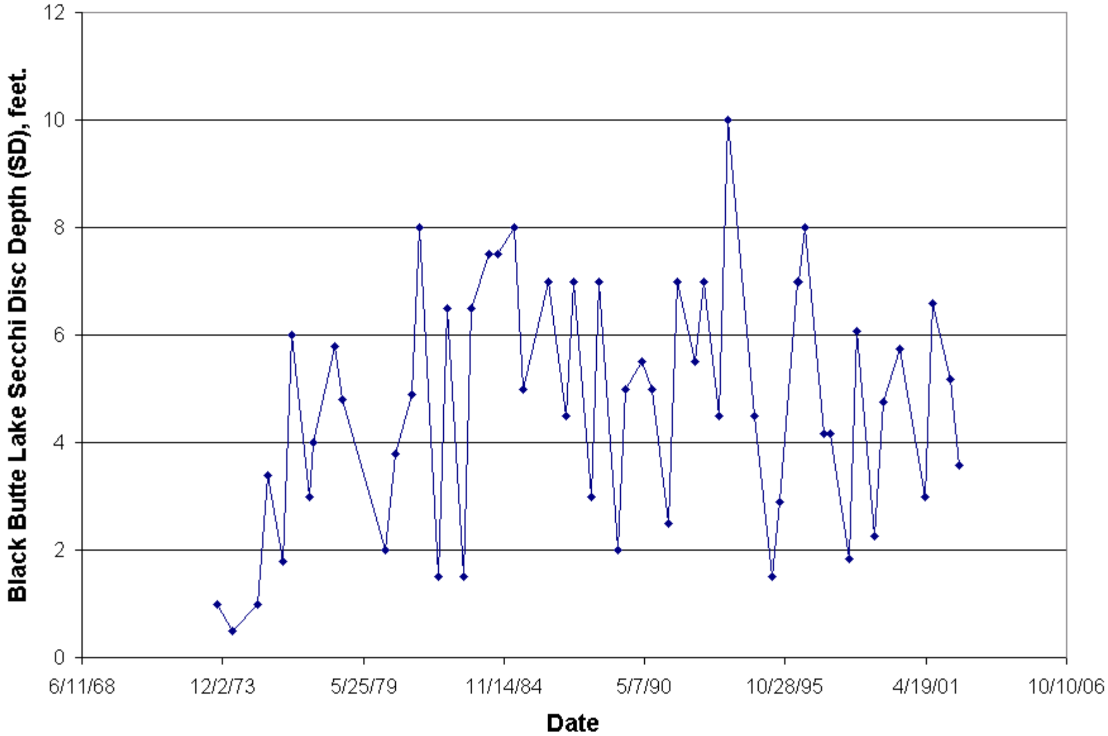

Figure 1. Historical Secchi Depth Values at Black Butte Lake (2002 values included).

The 2001 Water Quality Report listed only mercury as a contaminant of concern in Black Butte Lake. Due to high mercury concentrations in water found in 1999 and 2000 water samples, annual fish sampling was initiated in October 2000. While the mercury Maximum Contaminant Level (MCL = 2 ppb Hg) in water for human health was not exceeded, composite fish samples for mercury in 2000 and 2001 were 0.37 ppm and 0.58 ppm. Since both of these concentrations were above the U.S. Environmental Protection Agency's action level to continue fish tissue monitoring (0.3 ppm) fish monitoring was continued in 2002. The highest level for mercury in water (0.2 ppb) was found at the lake bottom in the Spring 2000 sample. In spring 2001 the concentration of mercury at the bottom was much lower (0.0049 ppb). .

III. Sample Summaries for This Year

Introduction

The following general summaries are split into their respective sample types. Each type of sample summary includes a discussion of both the Spring (April) and late Summer (August) samples to better examine trends within the current year. The types of parameters monitored this year include: Secchi Disc depths, water column profiles (temperature, DO and pH), phytoplankton characterization, metals concentrations, MTBE concentrations, Inorganic characterization (alkalinity, phosphorous, nitrogen, etc..), and fish mercury concentrations. For a more detailed explanation of the importance of each type of sample, please see Appendix A.

SECCHI DEPTH

The Secchi Disc depth found during the spring and late summer sampling in 2002 were similar to depths observed in previous years. Traditionally the lake had a higher clarity in the spring than in the late summer (Appendix B). In the spring the water clarity was higher and had a SD of 5.17 feet. The late summer SD of 3.58 feet was below the recreational goal of 4 feet.

TEMPERATURE VALUES

The temperature profiles for Black Butte Lake are indicative of a well-mixed shallow lake. A minimal amount of stratification can be seen in the spring, but disappears by the warm temperatures of late summer. While the depth of the lake at the spring and late summer sampling events was similar (spring depth = 85.3 feet, late summer depth= 78.7 feet), the average temperatures were very different (spring average temp. = 11.95 ºC , late summer average temp.= 24.34 ºC). The lake's temperature varies due to not having a deep-water area to buffer the warm summer air temperatures. Due to the warmth of the water, Black Butte Lake wouldn't reliably support coldwater fish species. For detailed temperature information obtained during the sampling events, please see Appendix B.

DISSOLVED OXYGEN

Dissolved oxygen (DO) concentrations differ greatly from spring to late summer. In the spring, DO concentrations are super saturated (12.2 mg/l DO) near the surface and high at the bottom (9.7 mg/L) of the lake. DO concentrations near the surface are above saturation (10.34 mg/l at 13.8ºC) due to phytoplankton photosynthesis. DO concentrations in the late summer are much lower and have a steady gradient from the surface (DO = 5.2 mg/l) to the bottom of the lake (DO =0.3 mg/l). The low DO values at the bottom of the lake are associated the decomposition of waste materials at accelerated rates due to the warm temperatures. Fish species that require greater than 5 mg/l DO and cooler water temperatures (< 20ºC) would be unlikely to survive in Black Butte Lake. For detailed results obtained during the sampling events, please see Appendix B.

PH LEVELS.

In the spring sample event, pH values in the lake were slightly basic (pH = ~7.4) throughout the water column. The pH values in the late summer profile varied widely. The pH generally was more basic towards the surface and middle waters (max pH = 8.8) and lowest at the bottom (pH = 7.8). The lower pH value at the bottom of the lake increases the likelihood that higher soluble metal concentrations will be in lake bottom samples. For detailed results obtained during the sampling events, please see Appendix B.

PHYTOPLANKTON

In the spring sample, the algal biomass in the lake was very low (Biomass = 94.7 µg/L) with green algae being the most dominant species. In late summer the phytoplankton population was much higher (Biomass = 1498.8 µg/L) with the largest concentration being diatoms, followed by blue green algae. For detailed results obtained during the sampling events, please see Appendix C.

METALS

All of the dissolved heavy metals were less than the maximum contaminant level (MCL) and the freshwater fishery criteria during either the spring or summer except for dissolved manganese. Manganese exceeded what is known as a "secondary" MCL. It is termed a secondary MCL because at the level established (50 ppb) it is not a health concern, but a water hardness concern. Every late summer sampling period, a higher concentration of dissolved manganese is found at the bottom of the lake. While there isn't a set fish criteria limit for manganese, the last two summers water at the bottom of Black Butte Lake has exceeded the secondary MCL for manganese (50 ppb). The concentration of dissolved manganese in summer lake bottom samples for 2001 and 2002 were 320 ppb and 420 ppb respectively. For detailed results obtained during the sampling events, please see Appendix D.

MTBE

All results were below the reporting limit of 2 ppb with one exception, 2 ppb in the spring lake sample. For detailed results obtained during the sampling events, please see Appendix F.

INORGANIC ANALYSIS

The spring sample analysis had several interesting results, but they weren't much different from the 2001 report. The 2002 alkalinity in the spring (100 mg/l CaCO3) was tied for the highest spring value of all the lakes monitored by the USACE. In spring 2001, alkalinity in Black Butte Lake was also high (110 mg/L CaCO3). The chloride concentration in the spring (Chloride = 13 ppm) was high when compared to other monitored lakes, but not much different from last year (Chloride = 10 ppm). Total Solids concentrations were the highest of all the lakes monitored this year (Lake TS = 170 mg/L), but were nearly identical to spring 2001 values.

Late summer 2002 sampling event results were similar to values from late summer 2001. The alkalinity was the highest value of all the lakes monitored (Lake Alkalinity =

140 mg/L CaCO3, Inlet Alkalinity= 150 mg/L CaCO3), which was also true in late summer 2001. Chloride concentrations were again high (Lake and Inlet Chloride =16 ppm) when compared to other lakes, but not significantly different from last year. Total solids values in the lake (Lake and Inlet TS = 200 mg/L) were the highest when compared to all of the monitored lakes in summer 2002, but were only 10 mg/L greater than last year. For detailed results obtained during the sampling events, please see Appendix E.

FISH SAMPLE ANALYSIS

Fish tissue analysis for total mercury was performed on a composite sample composed of tissue from three small mouth bass collected in June 2002. The composite sample had a resulting total mercury concentration of 0.26 ppm. This is well below the U.S. F.D.A. criteria for a fish advisory (1 ppm). The results were encouraging since small mouthed bass eat other fish and therefore are expected to bio-accumulate mercury, sometimes to high levels. The 2002 composite sample had a lower mercury concentration than both the 2000 (0.37 ppm) and 2001 (0.58 ppm) fish composite samples. Although the 2002 fish composite sample was below the California OEHHA screening level (0.3 ppm) to cease monitoring, monitoring of fish tissue will continue due to higher concentrations in previous years. For detailed results obtained during the sampling events, please see Appendix G.

IV. Conclusions

Black Butte Lake is a relatively shallow eutrophic lake that can support warmwater fish species. Coldwater fish species that require temperatures below 20°C and dissolved oxygen concentrations greater than 5 mg/L would have difficulty surviving summer conditions at Black Butte Lake. Due to a near neutral pH near the bottom of the lake and increased bacterial activities during the warm summer months, some metals within lake sediments are being converted into soluble forms.

Results from testing indicated no contaminants of concern in Black Butte Lake during the spring and summer sampling events. Contaminants in water and mercury within fish tissue will be monitored again in 2003.

V. References

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VI. Appendices

Appendix A: Glossary of Sample Types

Glossary of Sample Types

This glossary of sample types is intended to provide a general background and indicate the importance of each sample in determining water quality. These are meant to be brief and basic. If a further explanation is desired please refer to the list of references provided in this report.

Secchi Depth

One of the oldest and easiest methods to determine lake clarity is the Secchi depth (SD). The Secchi depth is determined by dropping a Secchi disc into a water body and determining the depth that it is last visible from the surface of the water. Secchi discs are generally white and 20 cm in diameter. Secchi depth values are most impacted by the light intensity at the time of sampling and the scattering of light by solid particulates within the water column. Algal growth (phytoplankton) and sediment re-suspension are often major constituents of solid particulates within the water column. Secchi depth values can be used to estimate the Trophic state or the nutrient levels within the lake. The more nutrients are available, the larger likelihood of algal blooms that limit water clarity. Due to recreational concerns for safety, the goal for Secchi depth values is four feet or greater.

Temperature Profiles and Data Points

The temperature profile of a lake provides information how a lake is operating and the potential for aquatic biota to live within the lake. The temperature profile is a direct indicator if a lake is stratified. Stratification in lakes is created generally by temperature affecting the density of water molecules. Stratification is usually indicated by a region of similar temperature nearer the surface of the water (epilimnion), then a region of temperature transition (metalimnion), to another layer of nearly constant temperature at the bottom of the lake (hypolimnion). Each layer in a stratified lake is important, but the existence of a hypolimnion can drastically impact how well a lake can handle warmer temperatures such as those found in northern California during the summer. The hypolimnion acts as a buffer against large temperature shifts. The nature of dam operation is that water is discharged near the bottom, releasing the hypolimnion, and eliminating stratification. This operation limits the ability of reservoirs to regulate their temperature during the summer months. Stratification isn't always desirable. When a lake isn't stratified and is instead well mixed, the required nutrients near the bottom of the lake become available to phytoplankton for growth. Temperatures within lakes also indicate which species of fish will survive within a lake. Coldwater species of fish require temperatures below 20 degrees C in order to spawn and survive. If a lake is often above 20 degrees C, then only warmwater fish species will survive.

Dissolved Oxygen (DO) Concentration Profiles

DO is required by organisms for respiration and for chemical reactions within lake waters. The recommended level for DO for most aquatic species survival is 5mg/L. In lakes, biota waste (detritus) falls to the bottom of the lake to be utilized by bacteria. The bacteria need oxygen and will deplete levels near the bottom of a lake, especially during

warm temperature, high respiration conditions. For nutrient rich (eutrophic) lakes more organisms will grow, create wastes, and cause oxygen depleted regions at the lowest areas. Under these conditions only aquatic species that can survive low DO conditions in warm water near the surface will survive.

PH Profiles

The pH profiles of the lakes indicate the potential for certain chemical reactions to occur. In high pH (greater than pH = 7 or basic) aquatic systems, metal pollutants tend to form into insoluble compounds that fall onto the lake floor. In low pH (less than pH = 7 or acidic) systems or areas metal ions become soluble and available for uptake into aquatic organisms. Other compounds like ammonia that are introduced into a low pH aquatic environment will transform into soluble nitrate and be utilized by organisms.

Phytoplankton Analysis

Phytoplankton analysis indicates the health, nutrients, and biodiversity within a lake. Lakes that have few nutrients available (Oligotrophic) will generally have a much lower quantity of phytoplankton (high Secchi depth) but the number of phytoplankton species seen will be large. In a lake that is nutrient rich (eutrophic) there are generally large phytoplankton blooms (low Secchi depth), but they are made up of a couple of phytoplankton species. Certain species of phytoplankton are preferred food sources for zooplankton (small invertebrates). Generally species like diatoms and green algae can be consumed by the filter-feeding zooplankton, but species like bluegreen algae are low in nutrients and are difficult to consume. Some species like the dinoflagellates can grow horn like points to discourage potential predators. In nutrient rich waters where there is plenty of phosphorous, nitrogen can be limited for biological growth. While most species can't grow due to the lack of nitrogen, bluegreen algae (cyanobacteria) have the ability to utilize nitrogen from the atmosphere when required. This gives bluegreen algae the ability to dominate in many eutrophic lakes.

Soluble Metals Analysis

The soluble metals analysis indicates the exposure of humans and aquatic organisms to toxic metals. These metals often build up as they are consumed through the food chain. Water samples provide an indicator for additional problems. Soluble forms of metal ions are more prevalent in low pH (pH <7, or acidic) environments.

MTBE Analysis

MTBE (methyl tertiary-butyl ether) is a chemical additive to gasoline to improve combustion. Due to its high solubility, MTBE travels and blends into aquatic systems rapidly. While not found to be extremely hazardous at low levels, the offensive smell and taste is detectible by humans at extremely low concentrations. The effect of MTBE on humans and aquatic systems is still under investigation.

Inorganic Analysis

Alkalinity

Alkalinity is measured in terms of mg/L of calcium carbonate. It indicates a lakes ability to buffer incoming acidic pollution and situational changes.

Ammonia

Ammonia is a gas that is toxic to fish and is more visible at a higher pH. Ammonia is created through anthropogenic inputs, bacteria cell respiration, and the decomposition of dead cells. Due to being a gas, given time ammonia will volatilize from the water. At a lower pH, much of the ammonia is converted to ammonium (a nutrient for root bound plant life) and utilizes DO in the nitrification process.

Chloride

The chloride ion is an indicator of any salinity increases within a lake. Most fresh water aquatic species are sensitive to salinity changes.

Nitrate

Nitrate is the nitrogen product created through the nitrification of ammonium. Nitrate is a soluble form of the nutrient nitrogen and is utilized by phytoplankton.

Total Phosphorous

The total phosphorous provides a measure of both utilized and soluble phosphorous within water samples. Phosphorous is a required nutrient for plant growth and development.

Ortho Phosphorous

Ortho phosphorous is the soluble form of phosphorous that is utilized by free-floating aquatic plants (phytoplankton).

Kjeldahl N

Kjeldahl nitrogen or total Kjeldahl nitrogen (TKN) is a measure of the total concentration of nitrogen in a sample. This includes ammonia, ammonium, nitrite, nitrate, nitrogen gas, and nitrogen contained within organisms.

COD

Chemical Oxygen Demand (COD) is a measure of the total oxygen required to complete the chemical and biological demands of a sample.

Fish Tissue Analysis

Fish tissue is analyzed to examine potential exposure of humans to toxicants as well as the health of the aquatic food chain. In aquatic systems toxic contaminants can build up (or bioaccumulate) within animals at the top of the food chain. Contaminants (especially organic pollutants) are retained within the fat tissue of an organism, therefore in fish samples the lipid content is often measured.

Lake Code Designation

Laboratory Reports are provided in the previous sections.

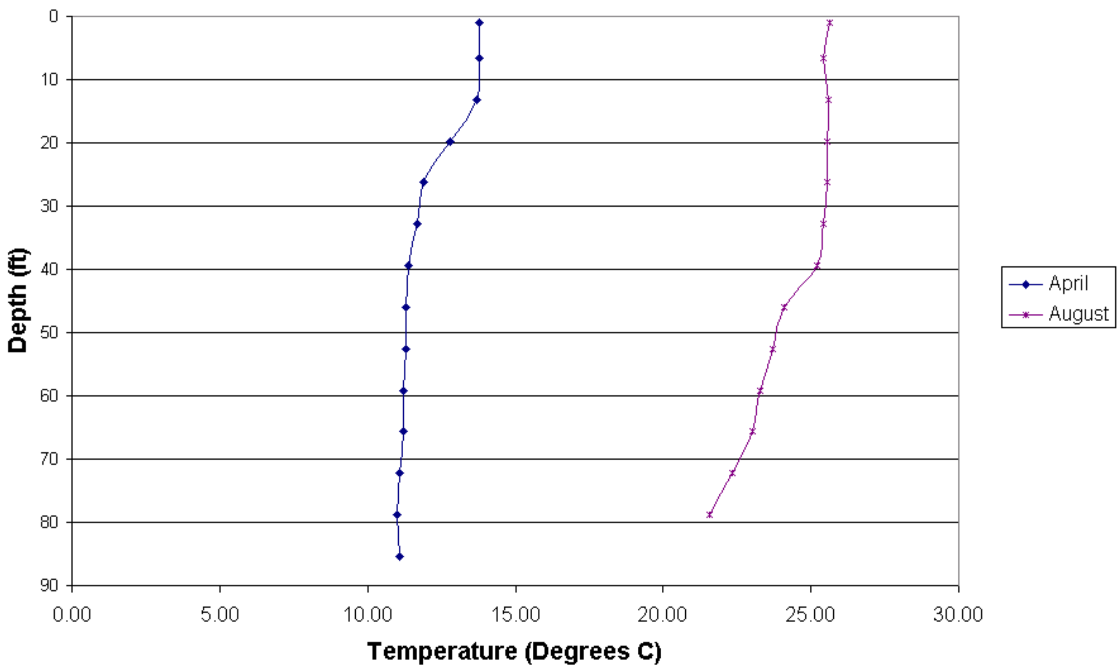
Sample ID is "XX-YY-ZZ" where

XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summar	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

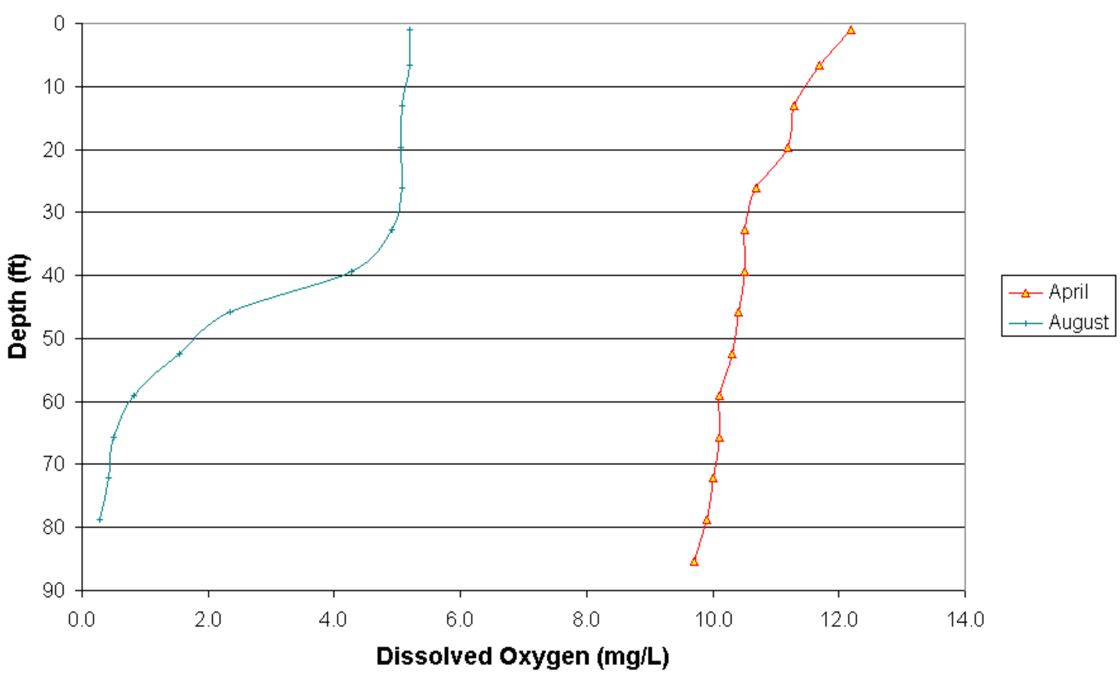
Example: BB-SU-S is for a water sample taken from Black Butte in the Summer on the Lake's Surface.

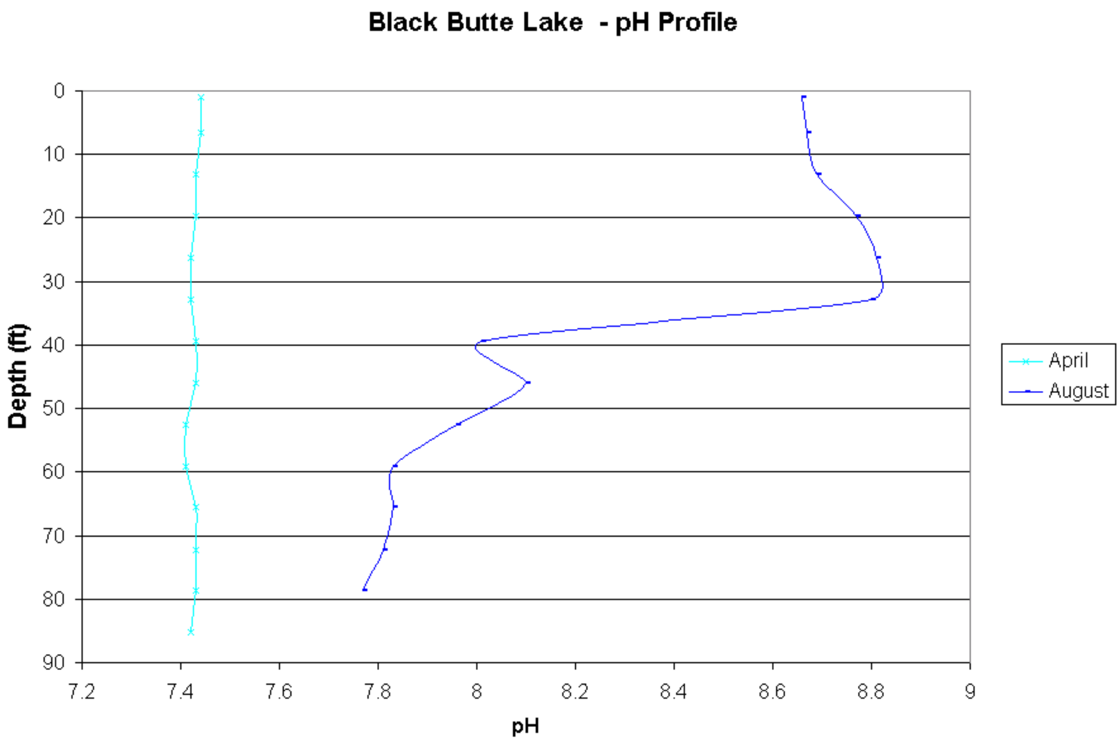
Appendix B: Profile Data and Charts (Secchi Disc, Temperature, DO, and pH)

Black Butte Lake - Temperature Profile



Black Butte Lake- Dissolved Oxygen Profile



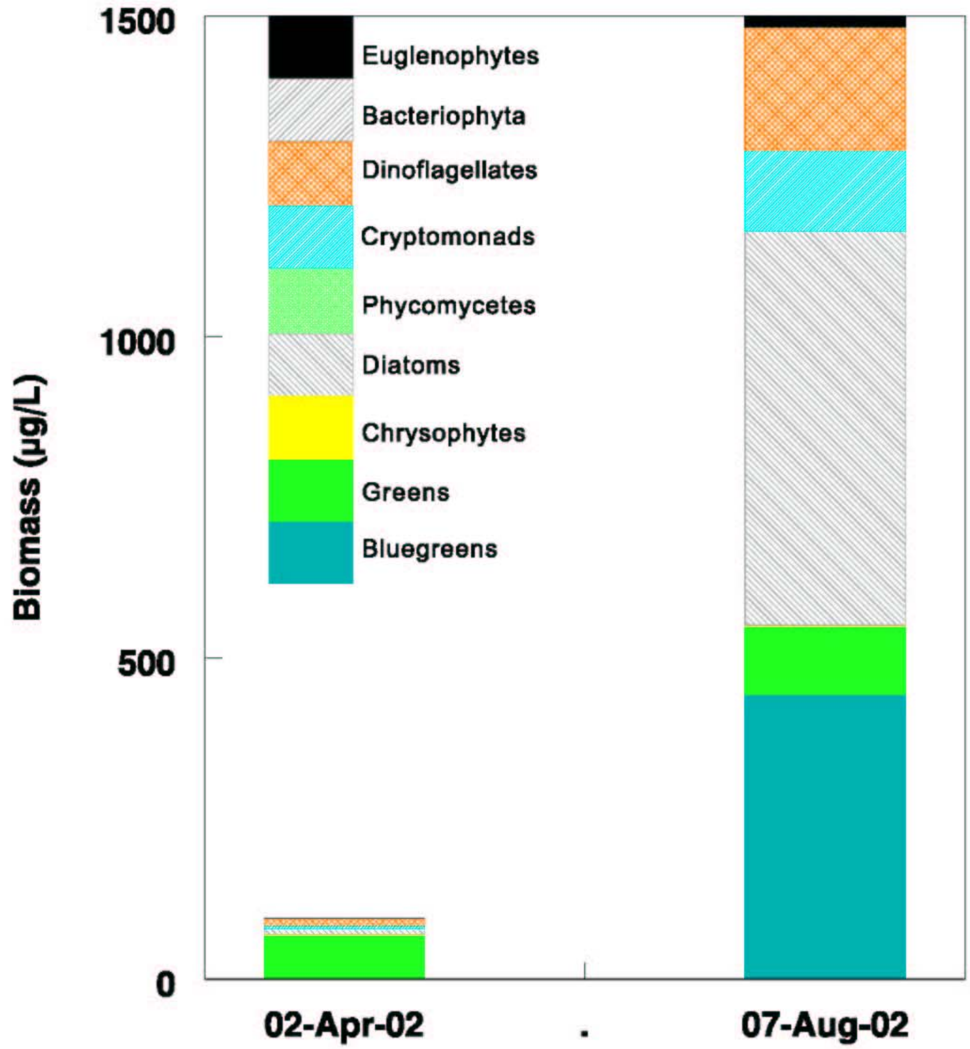

Black Butte Lake - pH Profile
Depth (ft)
pH
0
10
20
30
40
50
60
70
80
90
7.2
7.4
7.6
7.8
8
8.2
8.4
8.6
8.8
9
April
August

Black Butte					
Sample Location: Behind Dam				**Date:** 04/02/02	
Observers: Tim McLaughlin				**Time:** 10:45 am	
Lake Elevation: 461.8					
Weather Conditions:					
Wind Speed: 30		**Precipitation:** 0		**Temp (F):** 70	
SECCHI Depth: 5 feet and 2 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
24.8	85.3	11.10	266	9.7	7.42
24	78.7	11.00	266	9.9	7.43
22	72.2	11.10	266	10.0	7.43
20	65.6	11.20	264	10.1	7.43
18	59.1	11.20	265	10.1	7.41
16	52.5	11.30	265	10.3	7.41
14	45.9	11.30	265	10.4	7.43
12	39.4	11.40	265	10.5	7.43
10	32.8	11.70	265	10.5	7.42
8	26.2	11.90	265	10.7	7.42
6	19.7	12.80	266	11.2	7.43
4	13.1	13.70	267	11.3	7.43
2	6.6	13.80	267	11.7	7.44
0.03	1.0	13.80	267	12.2	7.44
NORTH FORK STONY CREEK (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
71.2	7.51		-	-	10
SOUTH FORK STONY CREEK (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
72.1	7.85		-	-	200
VISUAL OBSERVATIONS: Very windy with a muddy surface.					

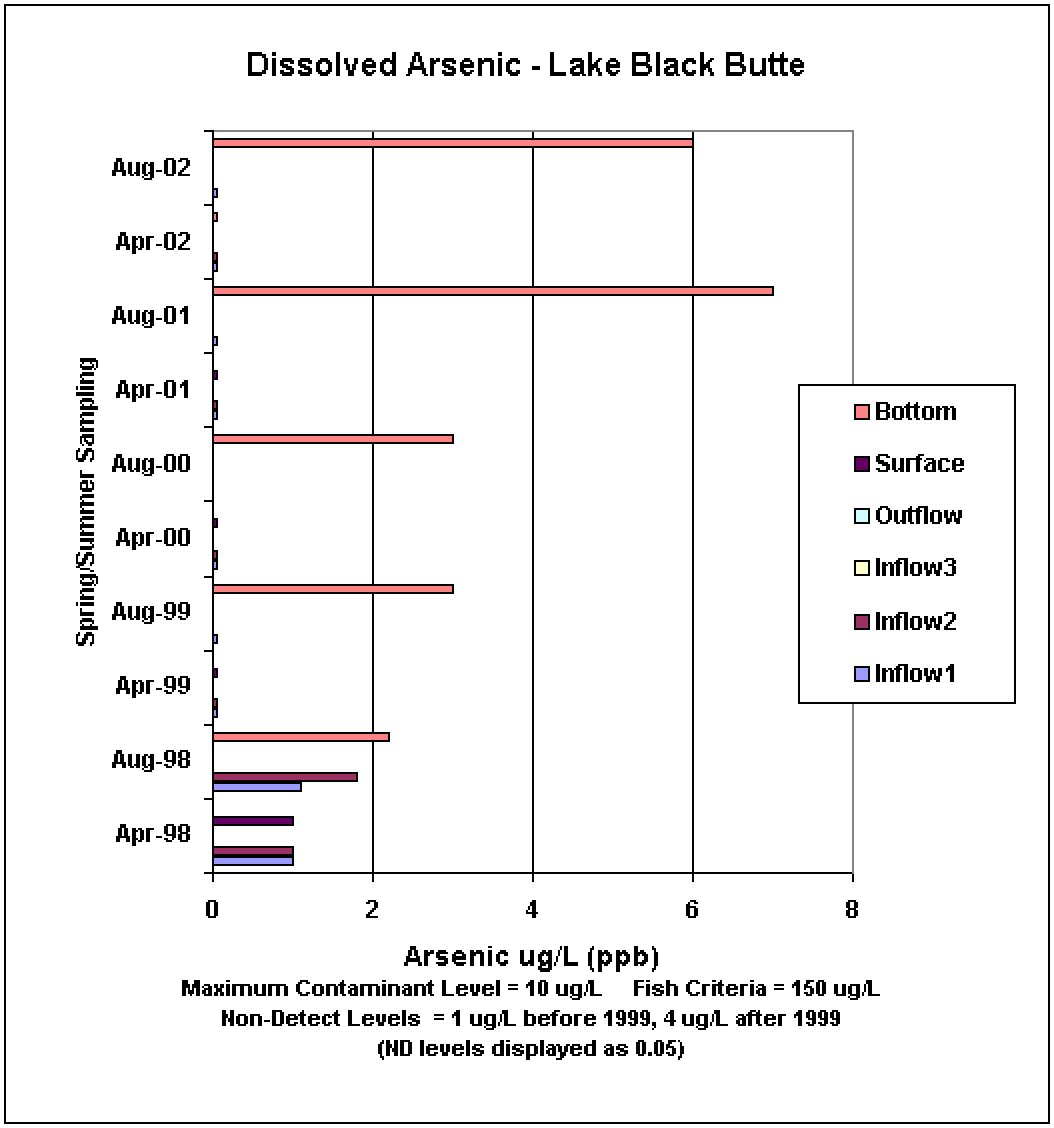
Black Butte					
Sample Location: Behind Dam				**Date:** 08/07/02	
Observers: Tim McLaughlin				**Time:** 10:45 am	
Lake Elevation: 456.76					
Weather Conditions:					
Wind Speed: 25		**Precipitation:** 0		**Temp (F):** 75	
SECCHI Depth: 3 feet and 7 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
23.7	78.7	21.58	349	0.3	7.77
22	72.2	22.34	347	0.4	7.81
20	65.6	23.04	350	0.5	7.83
18	59.1	23.30	352	0.8	7.83
16	52.5	23.72	352	1.6	7.96
14	45.9	24.09	352	2.3	8.1
12	39.4	25.19	349	4.3	8.01
10	32.8	25.42	345	4.9	8.8
8	26.2	25.56	346	5.1	8.81
6	19.7	25.57	346	5.1	8.77
4	13.1	25.60	346	5.1	8.69
2	6.6	25.43	345	5.2	8.67
0.03	1.0	25.62	346	5.2	8.66
NORTH FORK STONY CREEK (Inflow) - DRY					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
-	-		-	-	-
SOUTH FORK STONY CREEK (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
79.9	8.52		-	-	3
VISUAL OBSERVATIONS: Very windy. Strong hydrogen sulfide smell from bottom sample.					

Appendix C: Phytoplankton Data and Charts

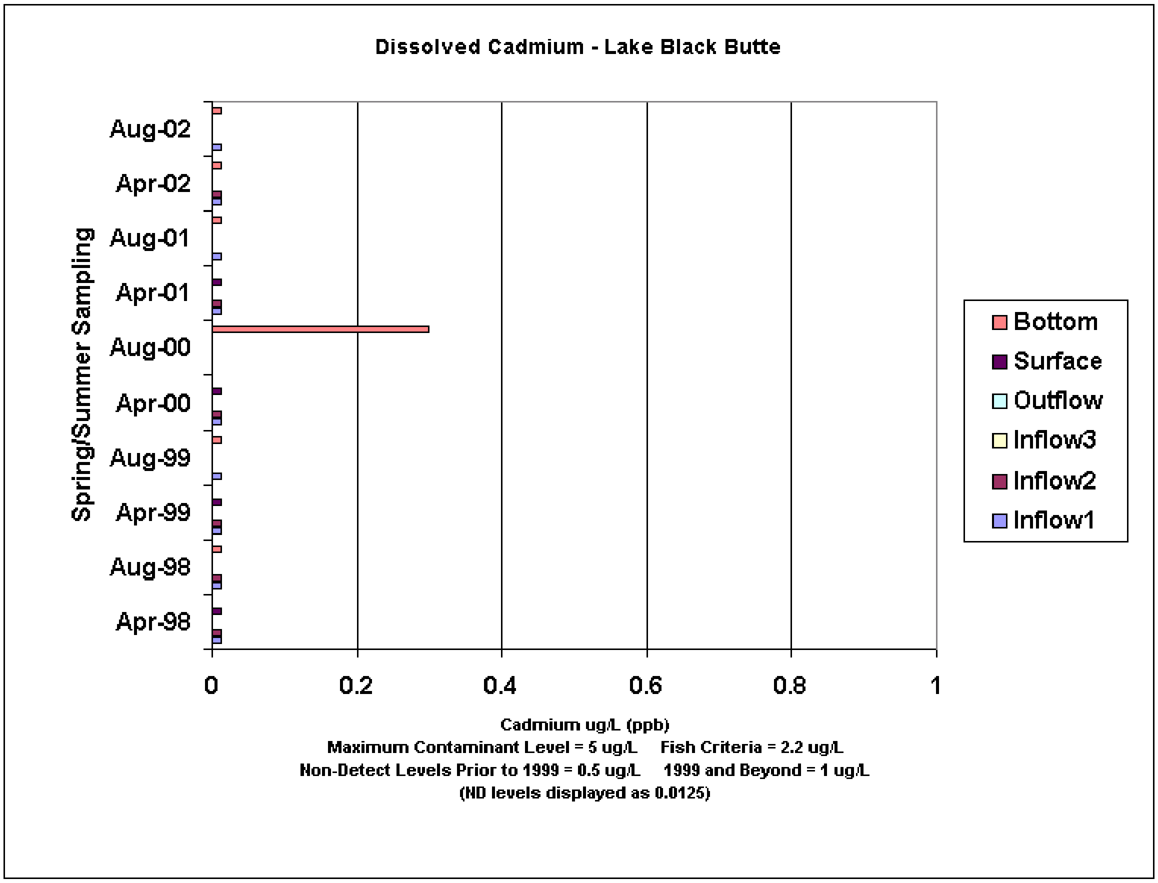
Phytoplankton Biomass 2002
Black Butte

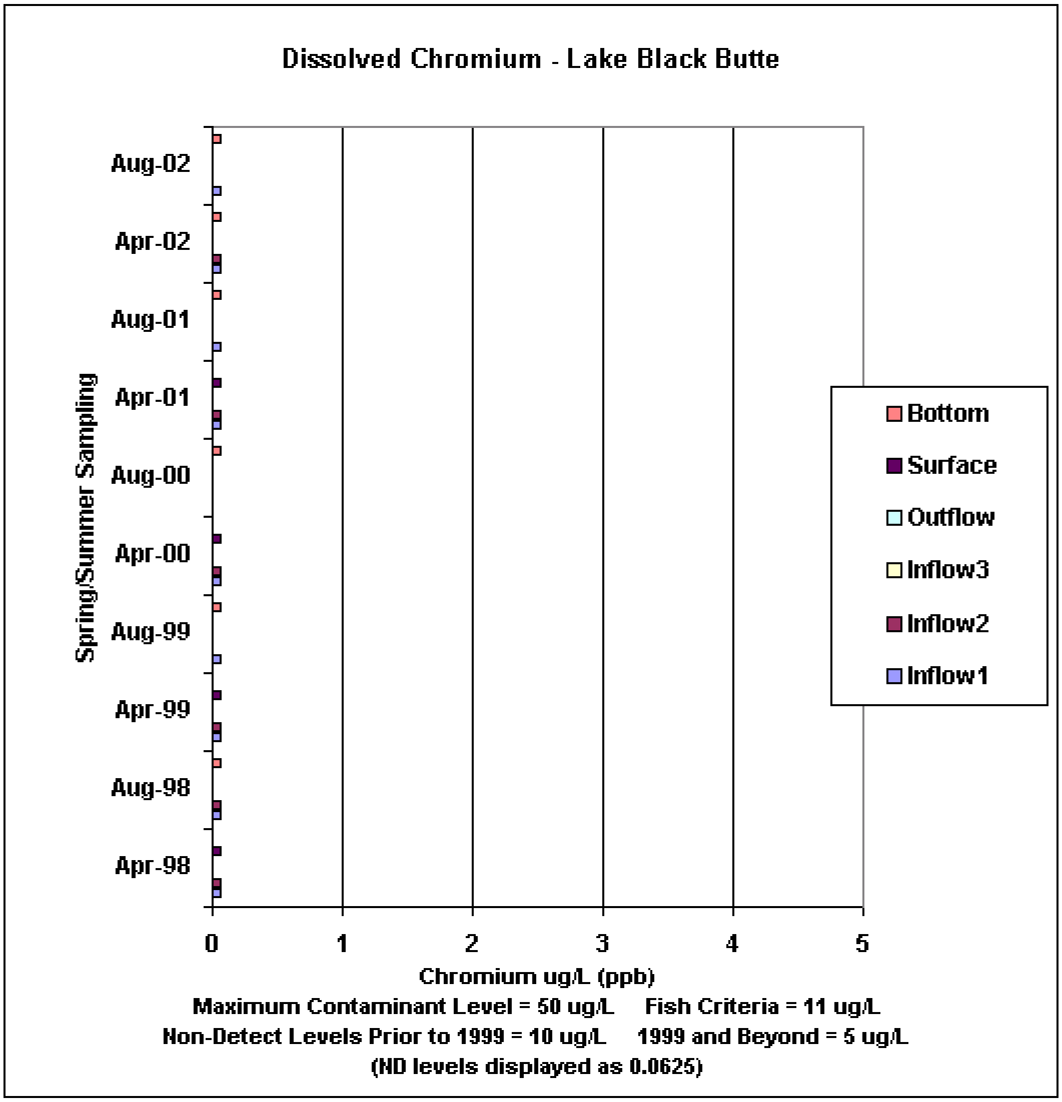


Appendix D: Metals Data and Charts

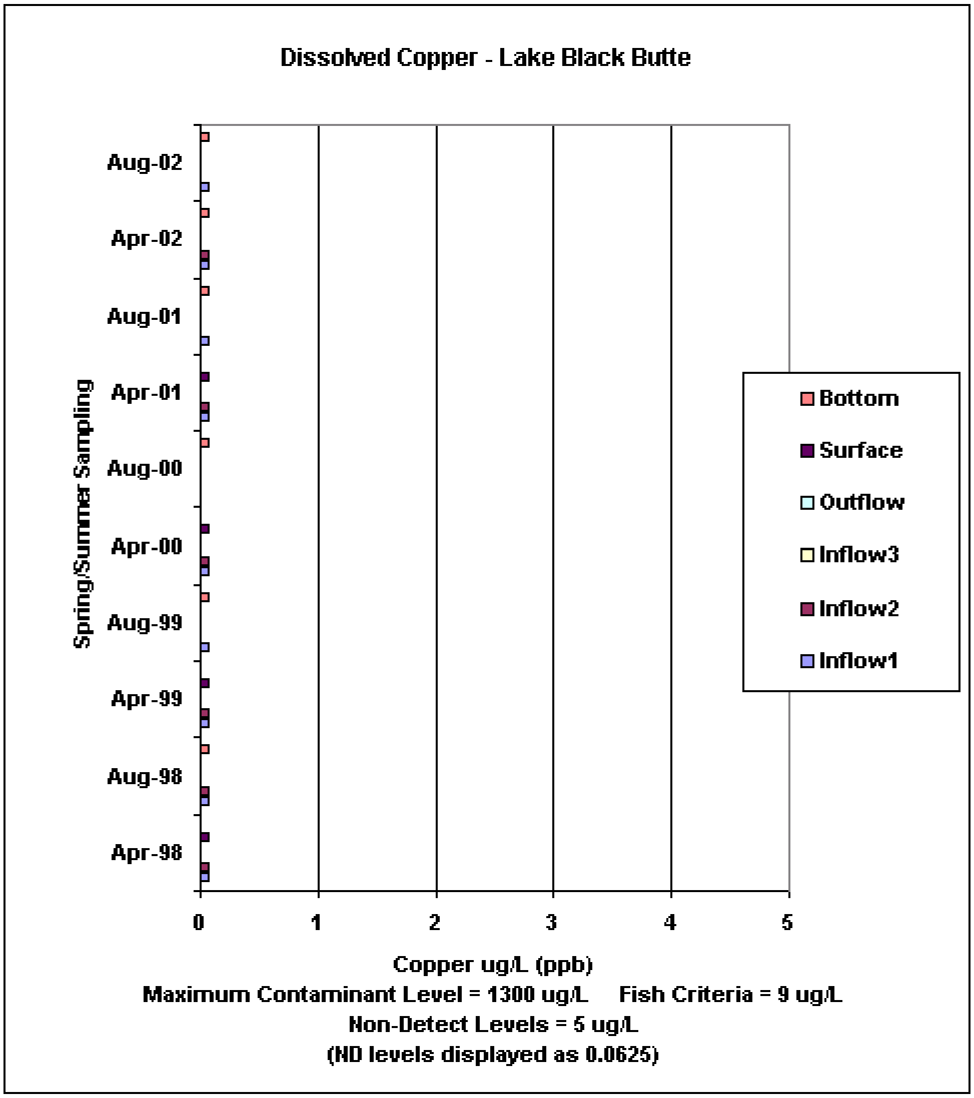


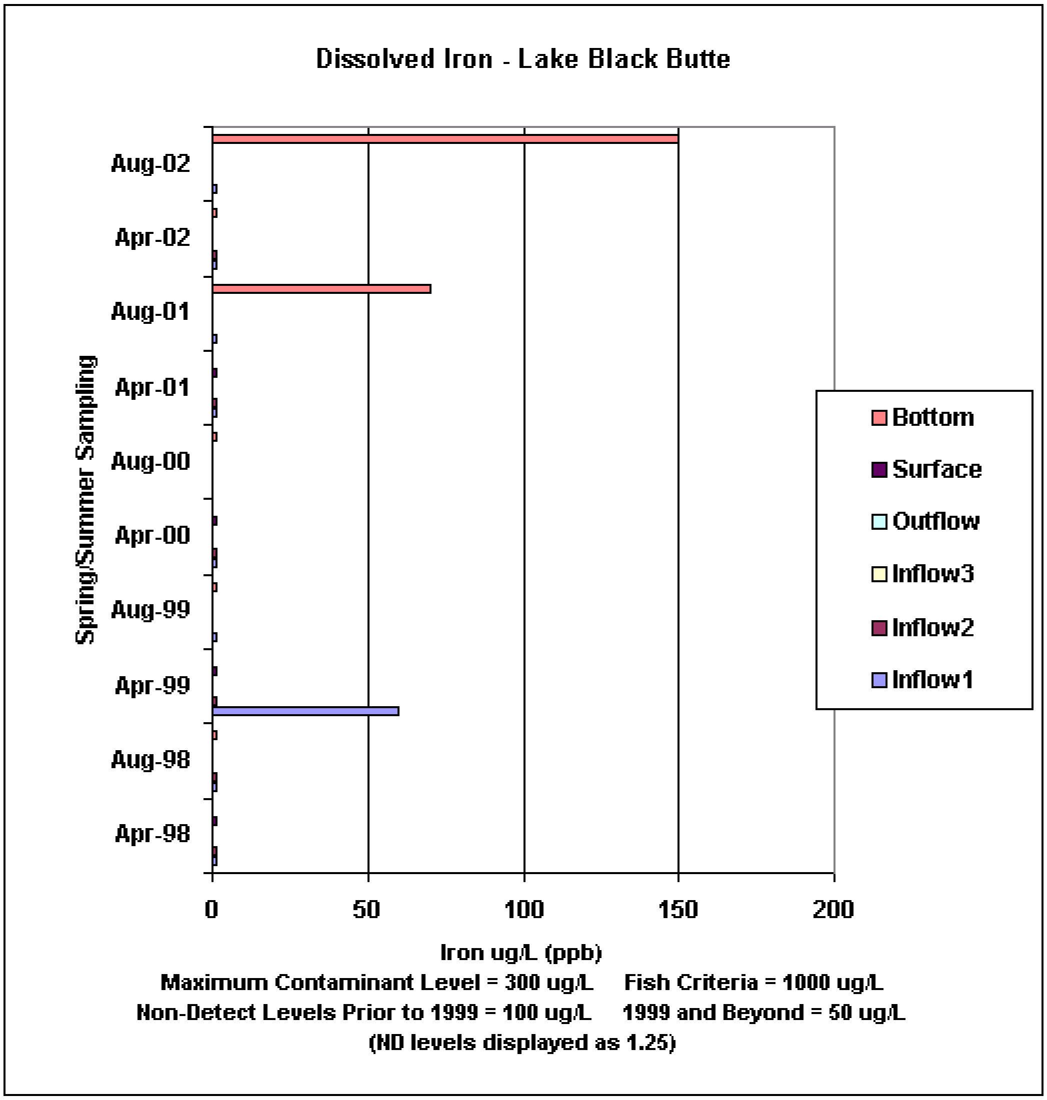
Dissolved Arsenic - Lake Black Butte
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Arsenic ug/L (ppb)
Maximum Contaminant Level = 10 ug/L
Fish Criteria = 150 ug/L
Non-Detect Levels = 1 ug/L before 1999, 4 ug/L after 1999
(ND levels displayed as 0.05)

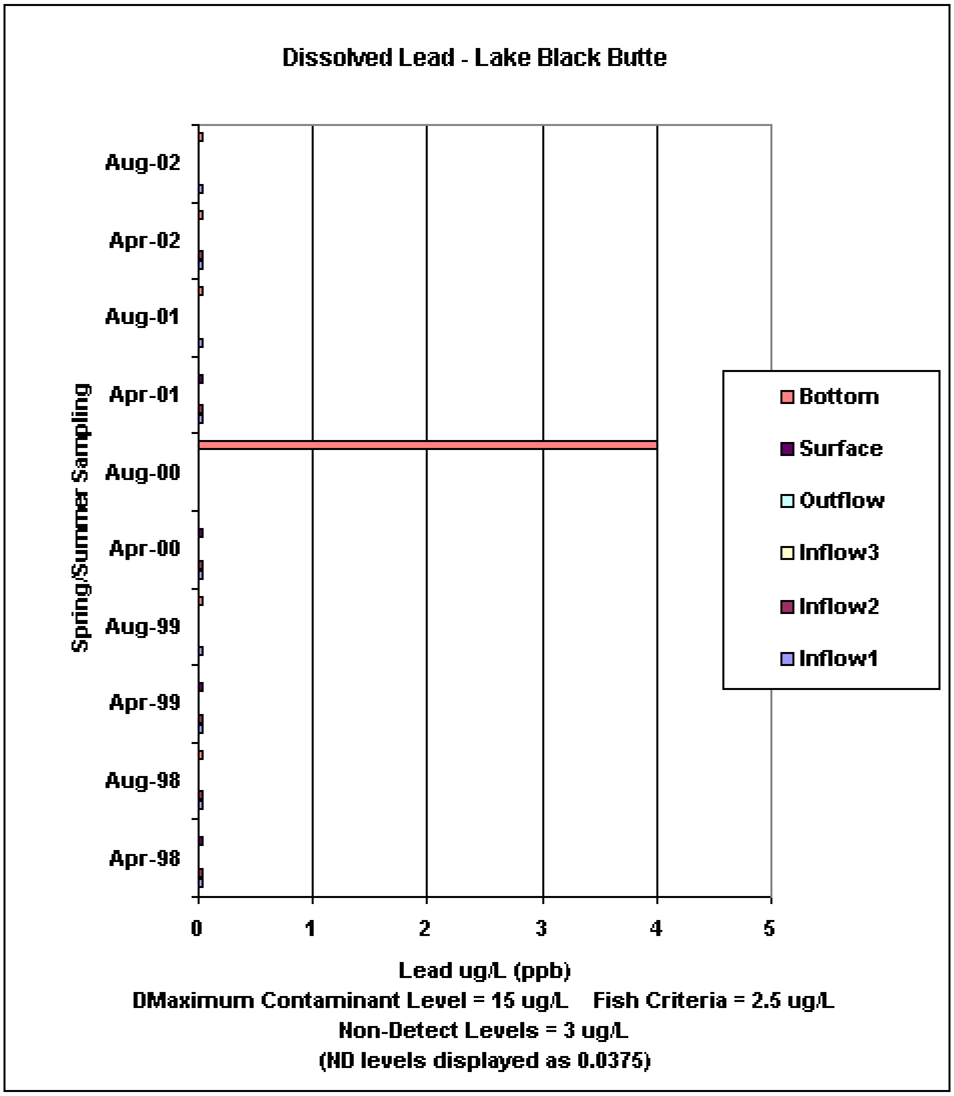

Dissolved Cadmium - Lake Black Butte
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.2
0.4
0.6
0.8
1
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Cadmium ug/L (ppb)
Maximum Contaminant Level = 5 ug/L   Fish Criteria = 2.2 ug/L
Non-Detect Levels Prior to 1999 = 0.5 ug/L   1999 and Beyond = 1 ug/L
(ND levels displayed as 0.0125)



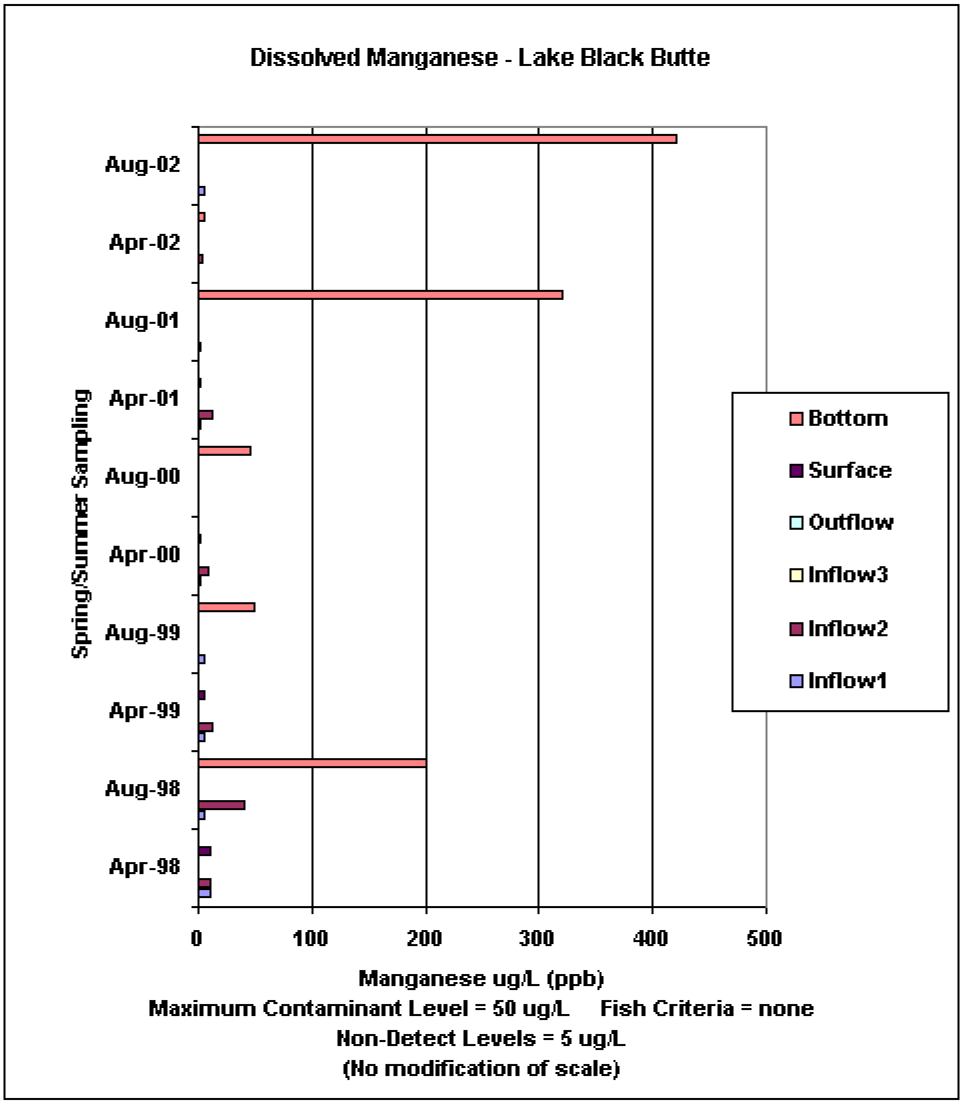
Dissolved Chromium - Lake Black Butte
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
5
Chromium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L   Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L   1999 and Beyond = 5 ug/L
(ND levels displayed as 0.0625)
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1


Dissolved Copper - Lake Black Butte
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
1
2
3
4
5
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Copper ug/L (ppb)
Maximum Contaminant Level = 1300 ug/L Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L
(ND levels displayed as 0.0625)

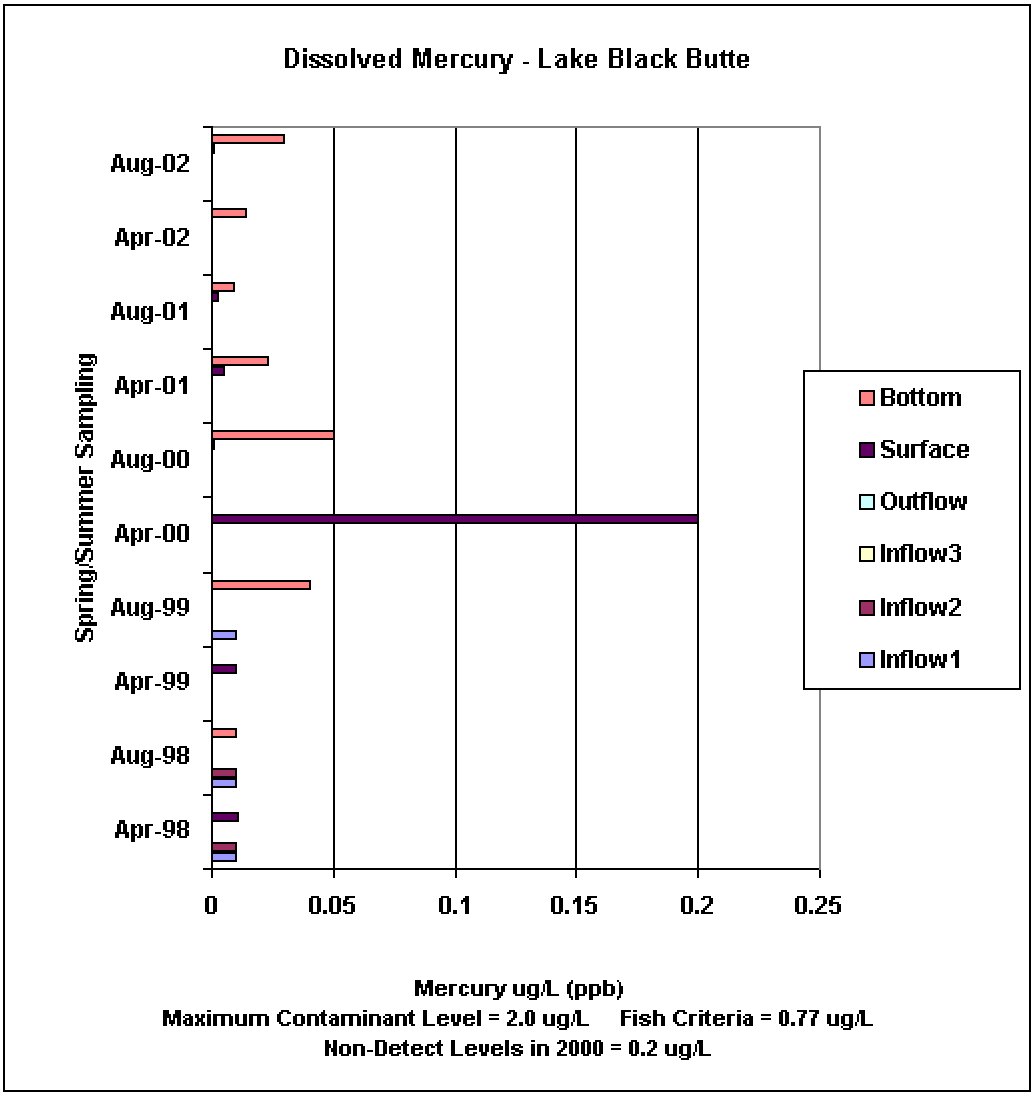

Dissolved Iron - Lake Black Butte
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
50
100
150
200
Iron ug/L (ppb)
Maximum Contaminant Level = 300 ug/L Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L 1999 and Beyond = 50 ug/L
(ND levels displayed as 1.25)
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1



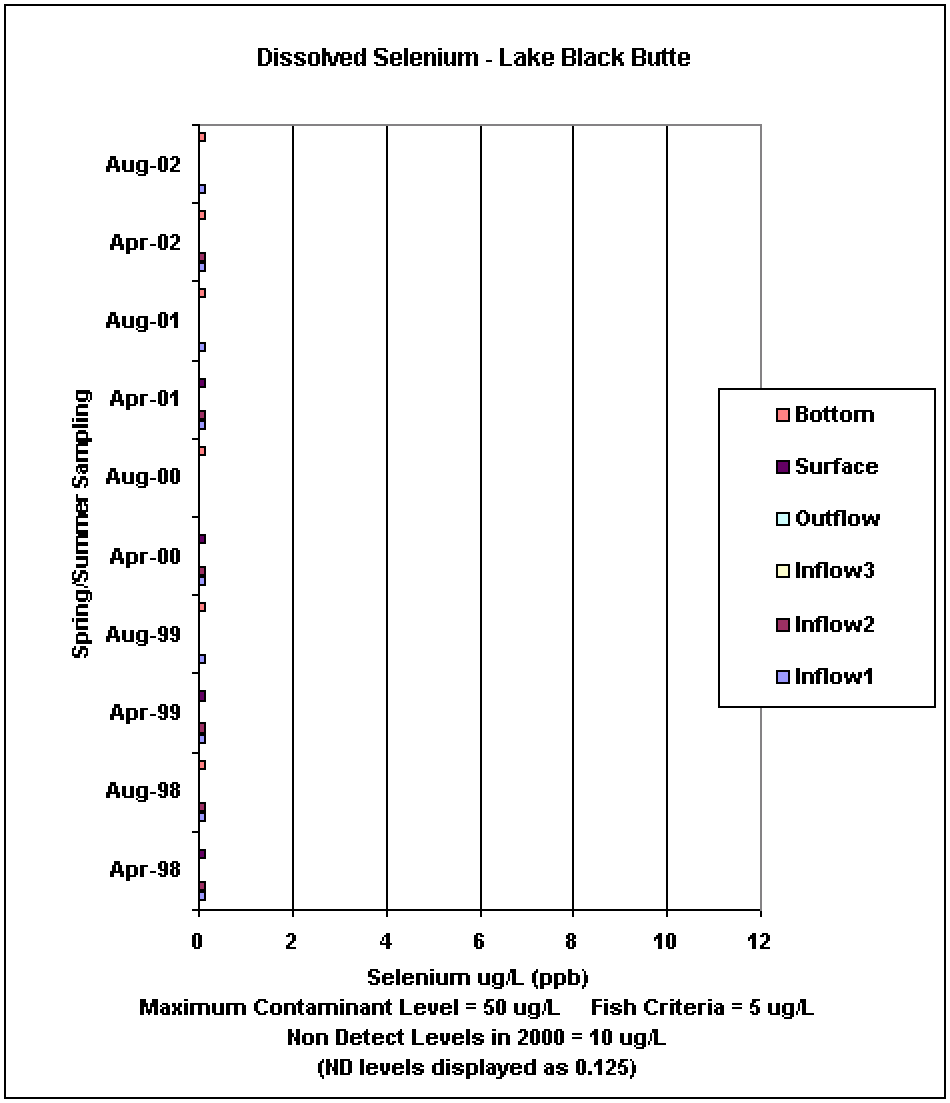
Dissolved Lead - Lake Black Butte
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
1
2
3
4
5
Lead ug/L (ppb)
DMaximum Contaminant Level = 15 ug/L
Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L
(ND levels displayed as 0.0375)
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1

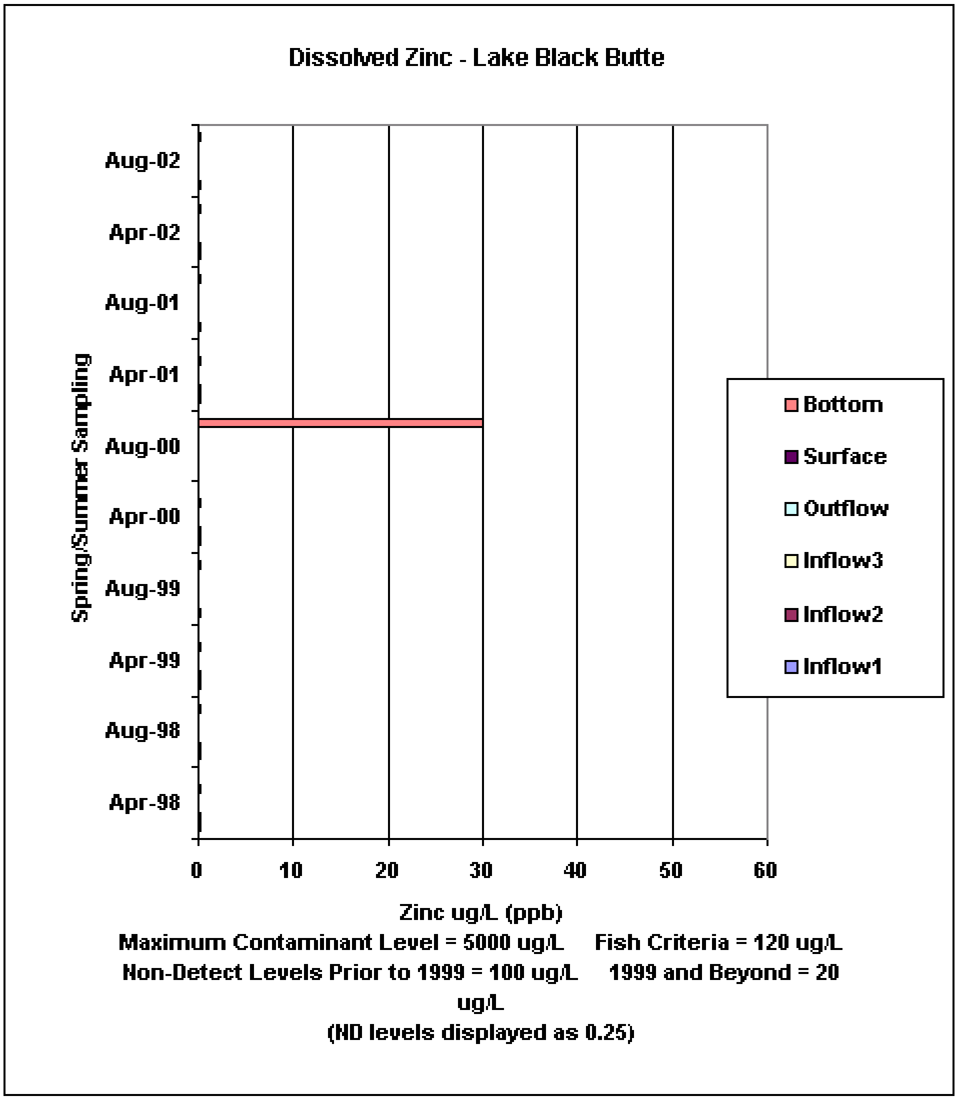


Dissolved Manganese - Lake Black Butte
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
100
200
300
400
500
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Manganese ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = none
Non-Detect Levels = 5 ug/L
(No modification of scale)



Dissolved Mercury - Lake Black Butte
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.05
0.1
0.15
0.2
0.25
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Mercury ug/L (ppb)
Maximum Contaminant Level = 2.0 ug/L
Fish Criteria = 0.77 ug/L
Non-Detect Levels in 2000 = 0.2 ug/L


Dissolved Selenium - Lake Black Butte
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
10
12
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Selenium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = 5 ug/L
Non Detect Levels in 2000 = 10 ug/L
(ND levels displayed as 0.125)


Dissolved Zinc - Lake Black Butte
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
10
20
30
40
50
60
Zinc ug/L (ppb)
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Maximum Contaminant Level = 5000 ug/L Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L 1999 and Beyond = 20 ug/L
(ND levels displayed as 0.25)

Appendix E: Inorganic Sample Data

Inorganic Results (mg/L) For surface lake waters (spring)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity		60	40	50	60	30	40	70	80	20		100
Ammonia		<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Chloride		21	2	21	4	4	3	<1	6	5		4
Nitrate		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1		<0.1
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Sulfate		5.3	2.6	4.2	8.9	2	1	8.2	9	2.1		4.7
Kjeldahl N		0.6	0.1	0.4	0.2	<0.1	0.3	0.2	0.2	0.2		<0.1
COD					<50							
Tot Solids		120	70	100	110	60	78	100	120	21		150

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	100	70	40	50	20	30	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	13	25	3	21	<1	<1	4	<1	6	4	3	2
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	
Sulfate	18	2.1	2.3	3	2.8	1.9	0.8	8.8	11	1.6	11	3.5
Kjeldahl N	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1
COD	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	170	130	59	110	60	60	90	110	150	30	130	90

Inorganic Results (mg/L) For surface lake waters (summer)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	140	70	40	50	50	40	70	90	80	10	80	110
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
Chloride	16	26	4	19	6	5	5	5	9	3	5	8
Nitrate	<0.1	1.5	<0.1	1.3	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1
Total P	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	16	4.1	3.6	3.5	5.9	2	0.7	7.4	14	1.6	6.4	4.4
Kjeldahl N	<0.1	2.7	<0.1	0.4	0.4	0.3	<0.1	0.2	<0.1	<0.1	0.2	0.6
COD	<50	60	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	200	190	50	120	98	80	80	120	120	52	100	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	90	40		60	40	80	100	130	20	110	180
Ammonia												
Chloride	16	490	5		10	8	3	5	14	4	5	22
Nitrate												
Total P												
Ortho P												
Sulfate	16	4.5	3		9.8	3.2	<0.5	6	14	2.7	5.4	8.7
Kjeldahl N												
COD												
Tot Solids	200	1300	50		140	100	100	150	200	50	140	280

Appendix F: MTBE Table

2002 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2002 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	2		2		<2		<2		
Eastman	5				<2				
Englebright	3		3		10		10	10	
Hensley	3		3		3		3		
Isabella	<2	<2	<2	<2	<2	<2	<2	<2	
Kaweah	2		2	<2	8		6	6	
Martis Cr.	<2				<2				
Mendocino	<2				<2				
New Hogan	<2				3				
Pine Flat	<2		<2		2		2		
Sonoma		3	<2		<2		2		
Success	4		4	4	11	12	11	11	

Notes:

1. Non-Detect is indicated by "<2" since the Reporting Limit is 2 ppb or 0.002 ppm.

2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.

3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.

4. For 2002, the number of MTBE water sampling at each lake is based on last year's lab results.

5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was historically non-detectable. The 2002 results of non-detectable levels were similar except Lake Eastman and New Hogan now reported low, detectable levels of MTBE.

6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because of historically low detectable levels of MTBE.

7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because of historically higher MTBE being found. The 2002 results were similar except Isabella now reported non-detectible levels.

8. In 2001, very high MTBE levels were reported at Lake Isabella during the Spring (18 ug/L near the marina) . During Spring 2000, Lake Isabella reported 21 ug/L. The 2002 results indicate that the previous MTBE problem near the marina was not visible during the Spring 2002 sampling event, and may have been rectified.

Appendix G: Fish tissue analysis table

2002 Fish Tissue Results

The following table provides an overview of the lab results for the 2002 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conductng the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The California OEHHA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Mercury Total ppm	FDA Criteria
Black Butte	Sm M Bass	Composite (3)	6/12/02	0.24	0.26	1 ppm
Eastman	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Englebright	Note 5	N/A	N/A	N/A	N/A	
Hensley	Black Bass	Composite (3)	4/23/02	<0.10	0.72	1 ppm
Isabella	Black Bass	Composite (3)	6/4/02	0.20	0.21	1 ppm
Kaweah	Sm M Bass	Composite (3)	7/14/02	0.11	0.53	1 ppm
Martis Cr	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Mendocino	Note 6	N/A	N/A	N/A	N/A	
New Hogan	Lg M Bass	Single (1)	6/3/02	<0.10	0.34	1 ppm
Pine Flat	Note 4	--------------------	-----------	----------	-----------	< Mon 01
Sonoma	Note 6	N/A	N/A	N/A	N/A	
Success	Black Bass	Composite (3)	4/15/02	<0.10	0.18	1 ppm

Notes:

9. Non-Detect is indicated by "<0.02". The lab Detection Limit for mercury is 0.02 ppm.
10. Total Mercury was reported in mg/g or ppm.
11. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.
12. The fish tissue program was terminated at Eastman and Martis Creek in 2001 and in Pine Flat in 2002 due to low total mercury results. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout). For Pine Flat total mercury was 0.21 ppm in 2000 (composite of three Sacramento Sucker fish) and 0.23 in 2001 (composite of three spotted bass).
13. Due to seasonal conditions, a fish could not be successfully collected at Lake Englebright. Another attempt will be accomplished for the 2003 report.

14. Fish were not collected at Mendocino or Sonoma due to communication difficulties.

The above 2002 total mercury results indicate only Hensley is higher than average. However, in 2001, the total mercury results were only 0.30 ppm for Hensley (small mouth bass). The 2003 fish tissue program should provide additional data. EPA fact sheet on fish advisories (EPA-823-F-99-016) indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.

Annual Water Quality Report

EASTMAN LAKE

Water Year 2002

Written by
John J. Baum
Water Quality Engineer
U. S. Army Corps of Engineers
Sacramento District
January 2003

TABLE OF CONTENTS

Eastman Lake

I. Purpose

This report is part of an environmental monitoring program that began at Eastman Lake in August 1976. The monitoring program was implemented to determine the water quality in the lake for both recreation and environmental health and to satisfy the Department of Army Engineering Regulation 1110-2-8154, “Water Quality and Environmental Management for Corps Civil Works Projects”.

II. Brief Description of Eastman Lake

Eastman Lake is located in central California, 23 miles northeast of Chowchilla, CA. The lake is nestled in the Sierra Nevada foothills and is surrounded by grasslands and blue oaks. At maximum capacity, the lake has 1,780 surface acres and holds 150,000 acre-feet of water. The lake was created by the construction of Buchanan Dam on the Chowchilla River. The dam is an earth and rockfill structure, 205 feet high, and 1,800 feet in length. Since being built by the US Army Corps of Engineers for flood control and irrigation, the lake has become a popular destination for recreation. At 600' elevation, summers are warm and the winters mild, allowing for year-round activities.

Generally there are two sample events a year, spring (April) and late summer (August). Since the start of the monitoring program, a water quality report is produced yearly to list results and address any concerns of the previous water year.

Historically Eastman Lake has a depth of < 90 ft, and is considered a mesotrophic lake when characterized by its clarity. A mesotrophic lake is one that has qualities between an oligotrophic lake (clear and nutrient limited, example Lake Tahoe) and a eutrophic lake (low clarity and high in nutrients, example, ClearLake). Similar to the eutrophic lakes monitored by the USACE, Eastman Lake has low dissolved oxygen (DO) concentrations in its lower depths during the warm late summer months. Additionally Eastman Lake is warm (>20ºC) in the late summer. Due to both the low DO concentrations and high temperatures, only warmwater fish species can reliably breed and survive in the lake. Warmwater fish species include bass, carp, perch, bluegill, crappie, and catfish. Although clearer than eutrophic (nutrient rich) lakes, mesotrophic lakes also can have low water clarity due to algal blooms. Additionally because the lake is relatively shallow, sediments suspended by wind action also impair its clarity. Water clarity is often measured in terms of Secchi Disc depth or SD (Appendix A). Historically the water clarity in Eastman Lake has been fair with ~14 % of the samples not meeting the recreational goal of 4 feet or greater (Figure 1). In 2001 the no Spring SD measure was taken, but the late summer sample was below the goal of 4 feet (SD = 3.75).

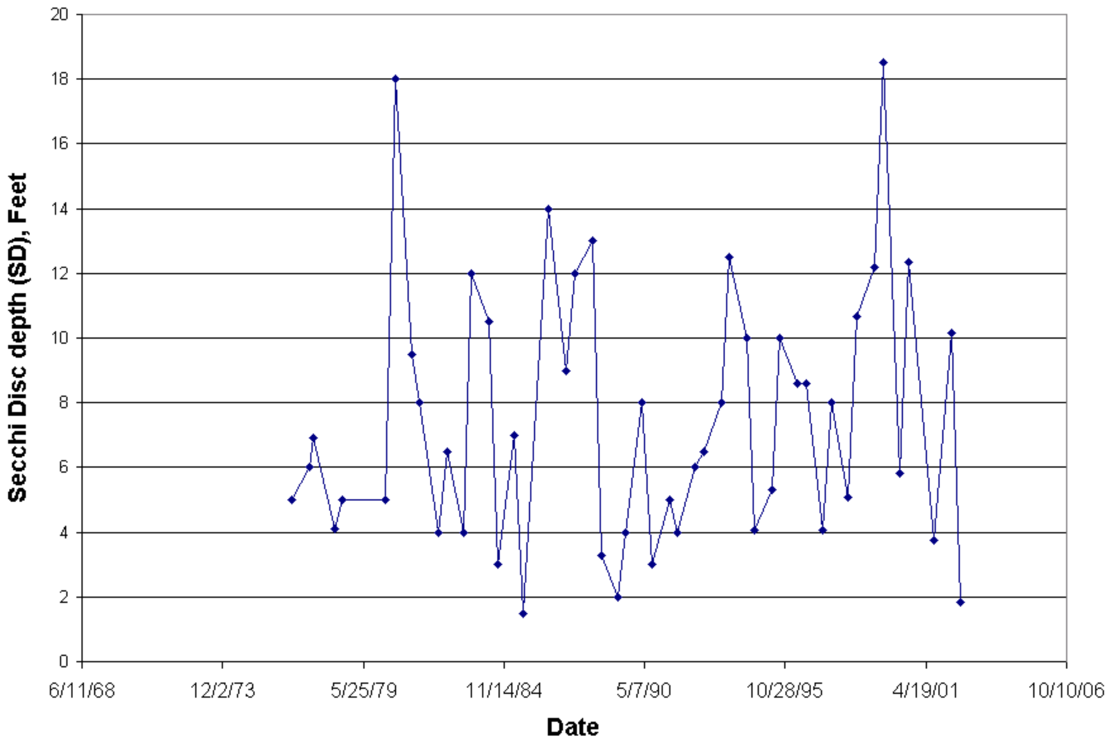


Figure 1. Historical Secchi Depth Values at Eastman Lake (2002 values included).

The 2001 Water Quality Report listed two contaminants of concern in Eastman Lake, mercury and manganese. Both of these contaminants were incorrectly listed due to the reasons discribed below. Since neither the maximum contaminant level (MCL = 2 ppb Hg) for human health nor the fish continuous exposure criteria concentration (0.77 ppb) was exceeded, mercury was inappropriately listed as a contaminant of concern for Lake Isabella. The highest level for mercury during 2000 and 2001 sample events was 0.035 ppb, well the below limits of concern. Since manganese has no fish criteria limit and only a secondary human MCL based on taste and water stains, manganese shouldn't have been listed as a contaminant of concern in previous reports.

III. Sample Summaries for this year.

Introduction

The following general summaries are split into their respective sample types. Each type of sample summary includes a discussion of both the spring (April) and late summer (August) samples to better examine trends within the current year. The types of parameters monitored this year include: Secchi Disc depths, water column profiles (temperature, DO and pH), phytoplankton characterization, metals concentrations, MTBE concentrations, and Inorganic characterization (alkalinity, phosphorous, nitrogen, etc..). Fish sampling in Eastman Lake was terminated in 2000 because results were below the OEHHA screening value of 0.3 ppm. For a more detailed explanation of the importance for each type of sample, please see Appendix A.

SECCHI DEPTH

The Secchi Disc depth found during the spring and late summer sampling were similar to previous events. Traditionally the lake had a higher clarity in the spring than in the late summer (Appendix B). In the spring the water clarity was higher and had a SD of 10.17 feet. The late summer SD of 1.83 feet was below the recreational goal of 4 feet and was the lowest value since late summer 1985.

TEMPERATURE VALUES

The temperature profiles for Eastman Lake are indicative of a seasonally well-mixed shallow lake. The lake is well stratified in the spring, but this disappears after exposure to the warm temperatures of late summer. The difference in the depth of the lake between the spring and late summer sampling events was considerable (spring depth = 85.3 feet, late summer depth= 59.1 feet). Partially due to this depth difference, the average temperatures were also very different (spring average temp. = 10.37 ºC, late summer average temp.= 23.86ºC). Eastman Lake's temperature varies seasonally due to its not having a deep-water area to buffer it from the warm summer air temperatures. Due to the warmth of the water, Eastman Lake wouldn't be able to support coldwater fish species reliably. For detailed results obtained during the sampling events, please see Appendix B.

DISSOLVED OXYGEN

The dissolved oxygen (DO) concentration in the lake differs greatly from spring to late summer. In the spring DO concentrations are supersaturated (11.08 mg/l DO) near the surface and low at the bottom (3.15 mg/L) of the lake. DO concentrations near the surface are above the saturation concentration of 9.36 mg/l (at 19.5ºC) due to phytoplankton photosynthesis. DO concentrations in the late summer are much lower and have a steady gradient from near the surface (DO = 5.12 mg/l) to the bottom of the lake (DO =0.87 mg/l). The low DO values at the bottom of the lake are associated the decomposition of waste materials at accelerated rates due to the warm temperatures. Fish species that require greater than 5 mg/l DO at cooler water temperatures (< 20ºC) would be unlikely to survive in Eastman Lake. For detailed results obtained during the sampling events, please see Appendix B.

PH Levels

In the spring sample event, pH values in the lake were slightly basic (pH = ~7.8) throughout the water column. The pH values in the late summer profile varied widely. The pH was more basic towards the surface and middle waters (max pH = 8.42) and very slightly acidic at the bottom (pH = 6.96). The lower pH value at the bottom of the lake increases the likelihood that higher soluble metal concentrations will be in lake bottom samples. For detailed results obtained during the sampling events, please see Appendix B.

PHYTOPLANKTON

In the spring sample, the algal biomass within the lake was high (Biomass = 906.5 ug/L) compared to spring 2001 (2001 Spring biomass = 312.0 ug/L). In spring 2001 green algae was the most dominant species, but in spring 2002 bluegreen algae dominated. In late summer the opposite trend occurred and the phytoplankton population was much higher in summer 2001 (2001 Summer Biomass = 8156.4 ug/L) than summer 2002 (Biomass = 2740.1 ug/L). Bluegreen algae were the most abundant species during both the 2001 and 2002 late summer sampling events. While most phytoplankton species must obtain nitrogen (a required nutrient for growth) from aqueous forms in the lake, bluegreen algae have the ability to use atmospheric nitrogen gas (by nitrogen fixation). In lakes that are limited in nitrogen availability, nitrogen fixing is a distinct advantage. Since nitrogen is limited in eutrophic lakes such as Eastman Lake, bluegreen algae has likely out competed the other species. Bluegreen algae is often thought of as a nuisance due to the inability of it to be used in the aquatic food chain and for its impact on water clarity. For detailed results obtained during the 2002 sampling events, please see Appendix C.

METALS

All heavy metals were less than the maximum contaminant level (MCL) or the freshwater fishery criteria during either the spring or summer except for dissolved iron and manganese which exceeded their secondary MCL's. For detailed results obtained during the sampling events, please see Appendix D.

The appearance of higher than historical copper concentrations in the bar chart in Appendix D must be addressed. While it would appear that this year's copper concentrations are much higher than anything seen in the recent past, this may not be the case because the values are still below the detection limits of the analytical procedure. (5 ppb) The appearance of the chart is attributable to the paradigm chosen for displaying so called "flagged" concentrations. As referred to in the Preface to this report, we chose to display "flagged" values below the detection limit if they were greater than 50% of the reporting limit which the lab interprets as the Practical Quantitation Limit (PQL). A supportable interpretation of the copper data is that in the past it has been "Non-Detect" and it remains so this year.

While dissolved iron concentrations had exceeded the secondary MCL (Iron MCL = 300 ppb) in the past, the late summer bottom iron concentration approached being twice as high (Iron on the bottom in summer = 750 ppb) as any previous value, but still did not exceed the fish criteria limit of 1000 ppb.

Every late summer sampling period, a higher concentration of dissolved manganese is flowing into the lake compared to ambient lake concentrations. While there isn't a set fish criteria limit for manganese, the last two summers water flowing into Eastman Lake has exceeded the secondary MCL for manganese in drinking water (50 ppb) which is based on aesthetic considerations. In late summer 2002, water flowing into the lake had a manganese concentration of 170 ppb. Additionally, this year the concentration of manganese in the bottom waters of the lake during the summer sampling period was abnormally high at 400 ppb, compared to the 2001 concentration of 7 ppb.

MTBE

Most results were below the reporting limit of 2ppb. The maximum reading was 5 ppb in the spring lake sample. For detailed results obtained during the sampling events, please see Appendix F.

INORGANIC ANALYSIS

The spring sample analysis had several interesting trends concerning concentrations of chloride, total solids, and nutrients (nitrogen and phosphorous).

The chloride concentration in the spring sampling event was much higher than the other lakes monitored by the USACE.

Spring total solids concentration was high when compared to all the lakes monitored (Lake TS = 120 mg/L, Inflow TS =130 mg/L), and have slightly increased each year since 2000 levels (Figure 2).

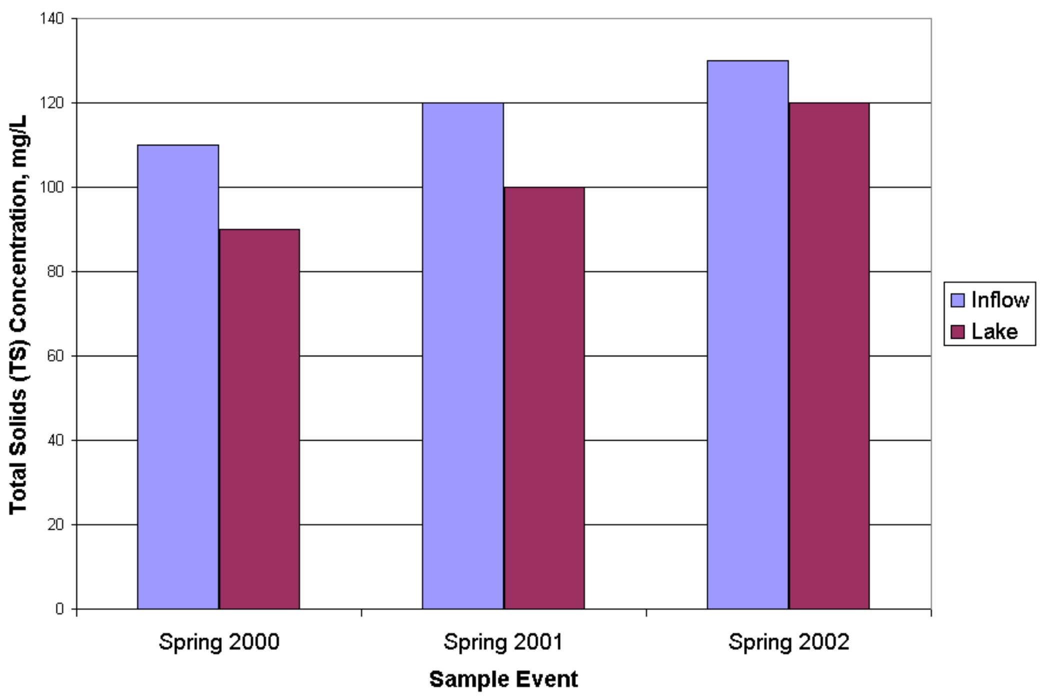


Figure 2. Spring Total Solids (TS) Concentrations.

Late summer Total Solids concentrations were extremely high (Lake Summer TS = 190 mg/L) and the inlet TS concentration (Inlet Summer TS = 1300 mg/L) is an area of concern (Figure 3). The increase in TS must be addressed considering that values have been increasing each year since 2000.

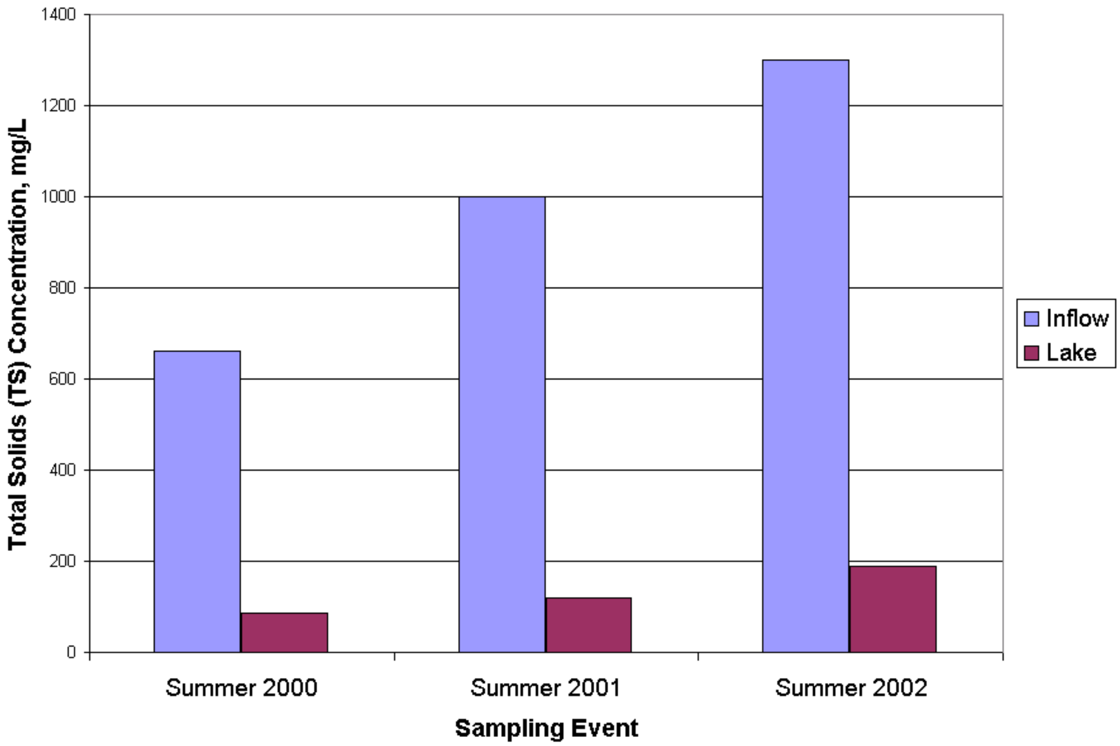


Figure 3. Late Summer Total Solids (TS) Concentrations.

Late summer 2002 sampling also indicated detectible levels of nutrients (nitrogen and phosphorous) in the lake. While nitrate values were below detection in the spring (< 0.1 mg/L), a concentration of 1.5 mg/L was found in the lake during the late summer sampling event Total Kjeldahl nitrogen (TKN) in the lake increased from 0.6 mg/L in the spring to 2.7 mg/L in the summer. Phosphorous concentrations increased from below detection levels (<0.1 mg/L) in the spring to a visible concentration in the summer. Ortho-phosphate was below detection during the summer event and total phosphorous was found to be 0.3 mg/L. The availability of nutrients may be directly related to the high concentration of total solids flowing into the lake. For detailed results obtained during the 2002 sampling events, please see Appendix E.

IV. Conclusions

Eastman Lake is a relatively shallow mesotrophic lake that can support warmwater fish species. Coldwater fish that require temperatures below 20°C and dissolved oxygen concentrations greater than 5 mg/L would have difficulties surviving the summer conditions at Eastman Lake. Due to a slightly acidic (<7) pH and the anaerobic conditions ideal for bacterial growth near the bottom of the lake during the late summer, some heavy metals within lake sediments are being converted into soluble forms.

Total Solids (TS) concentrations of inflowing water and within the lake have increased steadily over the last three years (2000 – 2002) and must be carefully monitored in the upcoming year. Associated with the increase in total solids is a reduction in clarity to below the recreational goal of 4 feet.

V. References

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VI. Appendices

Appendix A: Glossary of Sample Types

Glossary of Sample Types

This glossary of sample types is intended to provide a general background and indicate the importance of each sample in determining water quality. These are meant to be brief and basic. If a further explanation is desired please refer to the list of references provided in this report.

Secchi Depth

One of the oldest and easiest methods to determine lake clarity is the Secchi depth (SD). The Secchi depth is determined by dropping a Secchi disc into a water body and determining the depth that it is last visible from the surface of the water. Secchi discs are generally white and 20 cm in diameter. Secchi depth values are most impacted by the light intensity at the time of sampling and the scattering of light by solid particulates within the water column. Algal growth (phytoplankton) and sediment re-suspension are often major constituents of solid particulates within the water column. Secchi depth values can be used to estimate the Trophic state or the nutrient levels within the lake. The more nutrients are available, the larger likelihood of algal blooms that limit water clarity. Due to recreational concerns for safety, the goal for Secchi depth values is four feet or greater.

Temperature Profiles and Data Points

The temperature profile of a lake provides information how a lake is operating and the potential for aquatic biota to live within the lake. The temperature profile is a direct indicator if a lake is stratified. Stratification in lakes is created generally by temperature affecting the density of water molecules. Stratification is usually indicated by a region of similar temperature nearer the surface of the water (epilimnion), then a region of temperature transition (metalimnion), to another layer of nearly constant temperature at the bottom of the lake (hypolimnion). Each layer in a stratified lake is important, but the existence of a hypolimnion can drastically impact how well a lake can handle warmer temperatures such as those found in northern California during the summer. The hypolimnion acts as a buffer against large temperature shifts. The nature of dam operation is that water is discharged near the bottom, releasing the hypolimnion, and eliminating stratification. This operation limits the ability of reservoirs to regulate their temperature during the summer months. Stratification isn't always desirable. When a lake isn't stratified and is instead well mixed, the required nutrients near the bottom of the lake become available to phytoplankton for growth. Temperatures within lakes also indicate which species of fish will survive within a lake. Coldwater species of fish require temperatures below 20 degrees C in order to spawn and survive. If a lake is often above 20 degrees C, then only warmwater fish species will survive.

Dissolved Oxygen (DO) Concentration Profiles

DO is required by organisms for respiration and for chemical reactions within lake waters. The recommended level for DO for most aquatic species survival is 5mg/L. In lakes, biota waste (detritus) falls to the bottom of the lake to be utilized by bacteria. The bacteria need oxygen and will deplete levels near the bottom of a lake, especially during

warm temperature, high respiration conditions. For nutrient rich (eutrophic) lakes more organisms will grow, create wastes, and cause oxygen depleted regions at the lowest areas. Under these conditions only aquatic species that can survive low DO conditions in warm water near the surface will survive.

PH Profiles

The pH profiles of the lakes indicate the potential for certain chemical reactions to occur. In high pH (greater than pH = 7 or basic) aquatic systems, metal pollutants tend to form into insoluble compounds that fall onto the lake floor. In low pH (less than pH = 7 or acidic) systems or areas metal ions become soluble and available for uptake into aquatic organisms. Other compounds like ammonia that are introduced into a low pH aquatic environment will transform into soluble nitrate and be utilized by organisms.

Phytoplankton Analysis

Phytoplankton analysis indicates the health, nutrients, and biodiversity within a lake. Lakes that have few nutrients available (Oligotrophic) will generally have a much lower quantity of phytoplankton (high Secchi depth) but the number of phytoplankton species seen will be large. In a lake that is nutrient rich (eutrophic) there are generally large phytoplankton blooms (low Secchi depth), but they are made up of a couple of phytoplankton species. Certain species of phytoplankton are preferred food sources for zooplankton (small invertebrates). Generally species like diatoms and green algae can be consumed by the filter-feeding zooplankton, but species like bluegreen algae are low in nutrients and are difficult to consume. Some species like the dinoflagellates can grow horn like points to discourage potential predators. In nutrient rich waters where there is plenty of phosphorous, nitrogen can be limited for biological growth. While most species can't grow due to the lack of nitrogen, bluegreen algae (cyanobacteria) have the ability to utilize nitrogen from the atmosphere when required. This gives bluegreen algae the ability to dominate in many eutrophic lakes.

Soluble Metals Analysis

The soluble metals analysis indicates the exposure of humans and aquatic organisms to toxic metals. These metals often build up as they are consumed through the food chain. Water samples provide an indicator for additional problems. Soluble forms of metal ions are more prevalent in low pH (pH <7, or acidic) environments.

MTBE Analysis

MTBE (methyl tertiary-butyl ether) is a chemical additive to gasoline to improve combustion. Due to its high solubility, MTBE travels and blends into aquatic systems rapidly. While not found to be extremely hazardous at low levels, the offensive smell and taste is detectible by humans at extremely low concentrations. The effect of MTBE on humans and aquatic systems is still under investigation.

Inorganic Analysis

Alkalinity

Alkalinity is measured in terms of mg/L of calcium carbonate. It indicates a lakes ability to buffer incoming acidic pollution and situational changes.

Ammonia

Ammonia is a gas that is toxic to fish and is more visible at a higher pH. Ammonia is created through anthropogenic inputs, bacteria cell respiration, and the decomposition of dead cells. Due to being a gas, given time ammonia will volatilize from the water. At a lower pH, much of the ammonia is converted to ammonium (a nutrient for root bound plant life) and utilizes DO in the nitrification process.

Chloride

The chloride ion is an indicator of any salinity increases within a lake. Most fresh water aquatic species are sensitive to salinity changes.

Nitrate

Nitrate is the nitrogen product created through the nitrification of ammonium. Nitrate is a soluble form of the nutrient nitrogen and is utilized by phytoplankton.

Total Phosphorous

The total phosphorous provides a measure of both utilized and soluble phosphorous within water samples. Phosphorous is a required nutrient for plant growth and development.

Ortho Phosphorous

Ortho phosphorous is the soluble form of phosphorous that is utilized by free-floating aquatic plants (phytoplankton).

Kjeldahl N

Kjeldahl nitrogen or total Kjeldahl nitrogen (TKN) is a measure of the total concentration of nitrogen in a sample. This includes ammonia, ammonium, nitrite, nitrate, nitrogen gas, and nitrogen contained within organisms.

COD

Chemical Oxygen Demand (COD) is a measure of the total oxygen required to complete the chemical and biological demands of a sample.

Fish Tissue Analysis

Fish tissue is analyzed to examine potential exposure of humans to toxicants as well as the health of the aquatic food chain. In aquatic systems toxic contaminants can build up (or bioaccumulate) within animals at the top of the food chain. Contaminants (especially organic pollutants) are retained within the fat tissue of an organism, therefore in fish samples the lipid content is often measured.

Lake Code Designation

Laboratory Reports are provided in the previous sections.

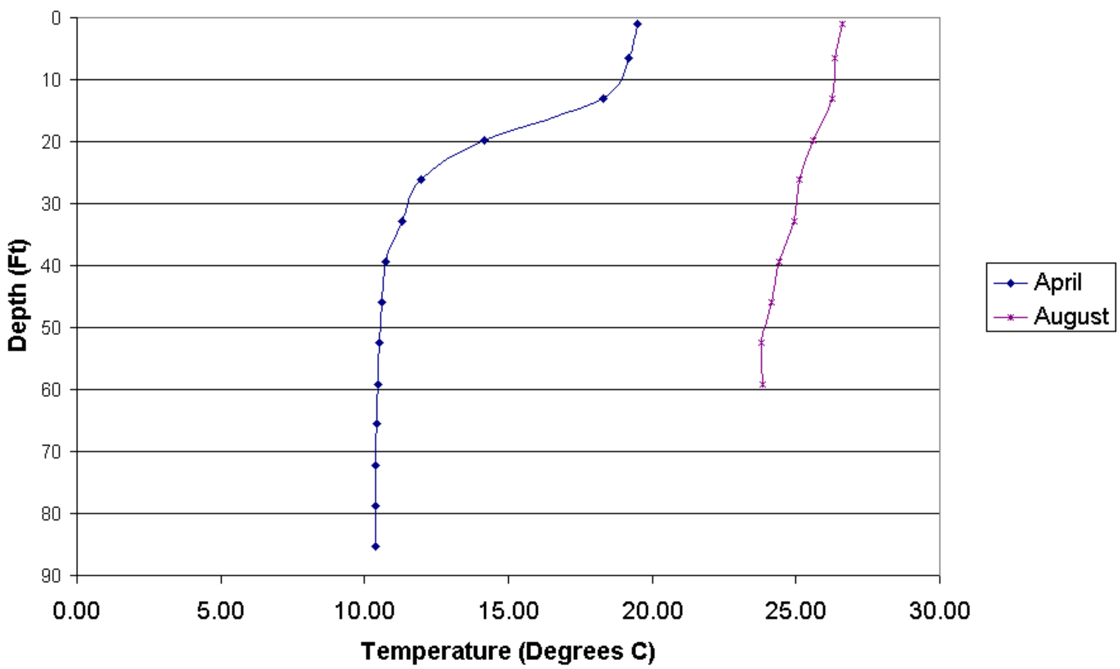
Sample ID is "XX-YY-ZZ" where

XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summer	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

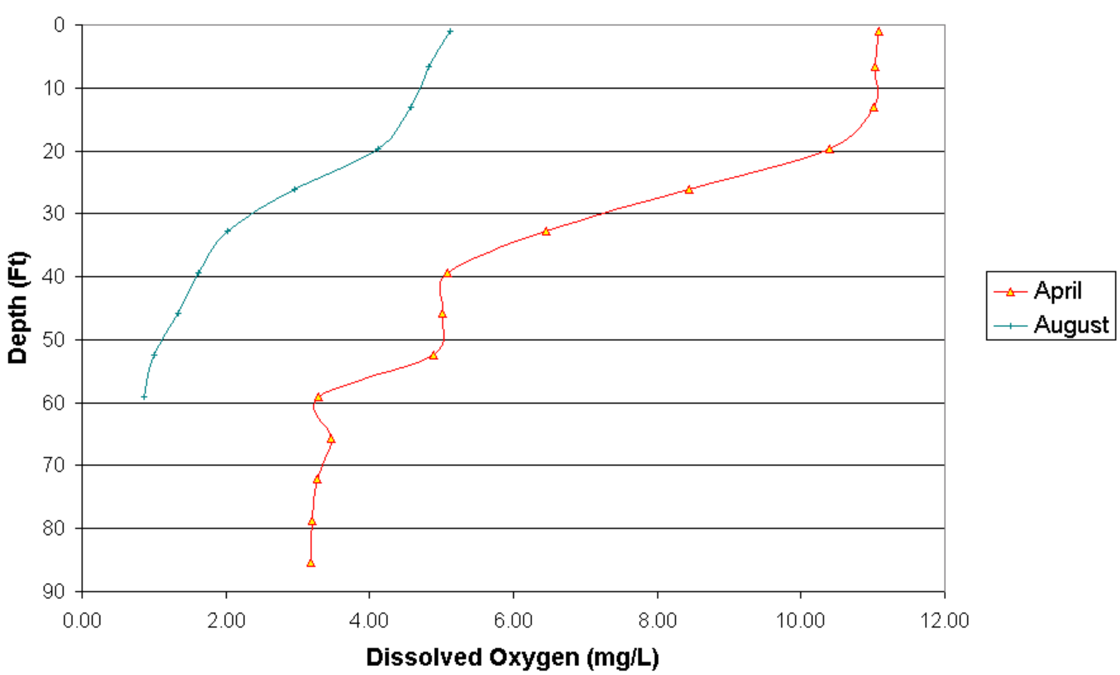
Example: BB-SU-S is for a water sample taken from Black Butte in the Summer on the Lake's Surface.

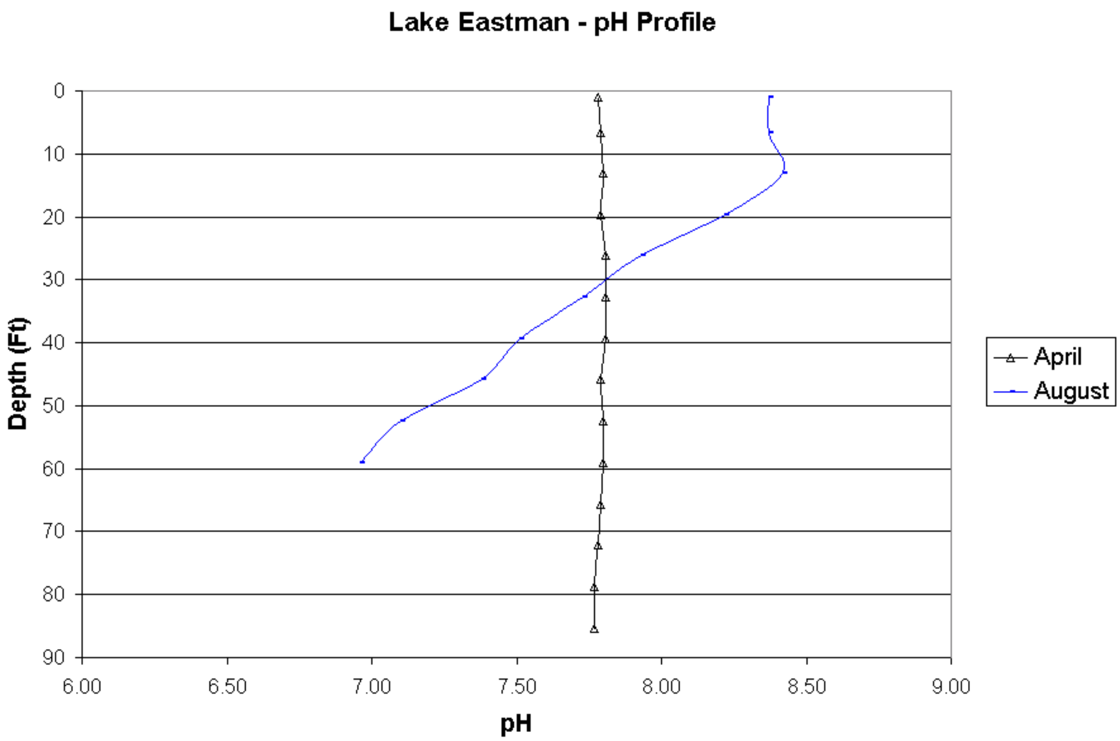
Appendix B: Profile Data and Charts (Secchi Disc, Temperature, DO, and pH)

Eastman Lake - Temperature Profile



Eastman Lake - Dissolved Oxygen Profile



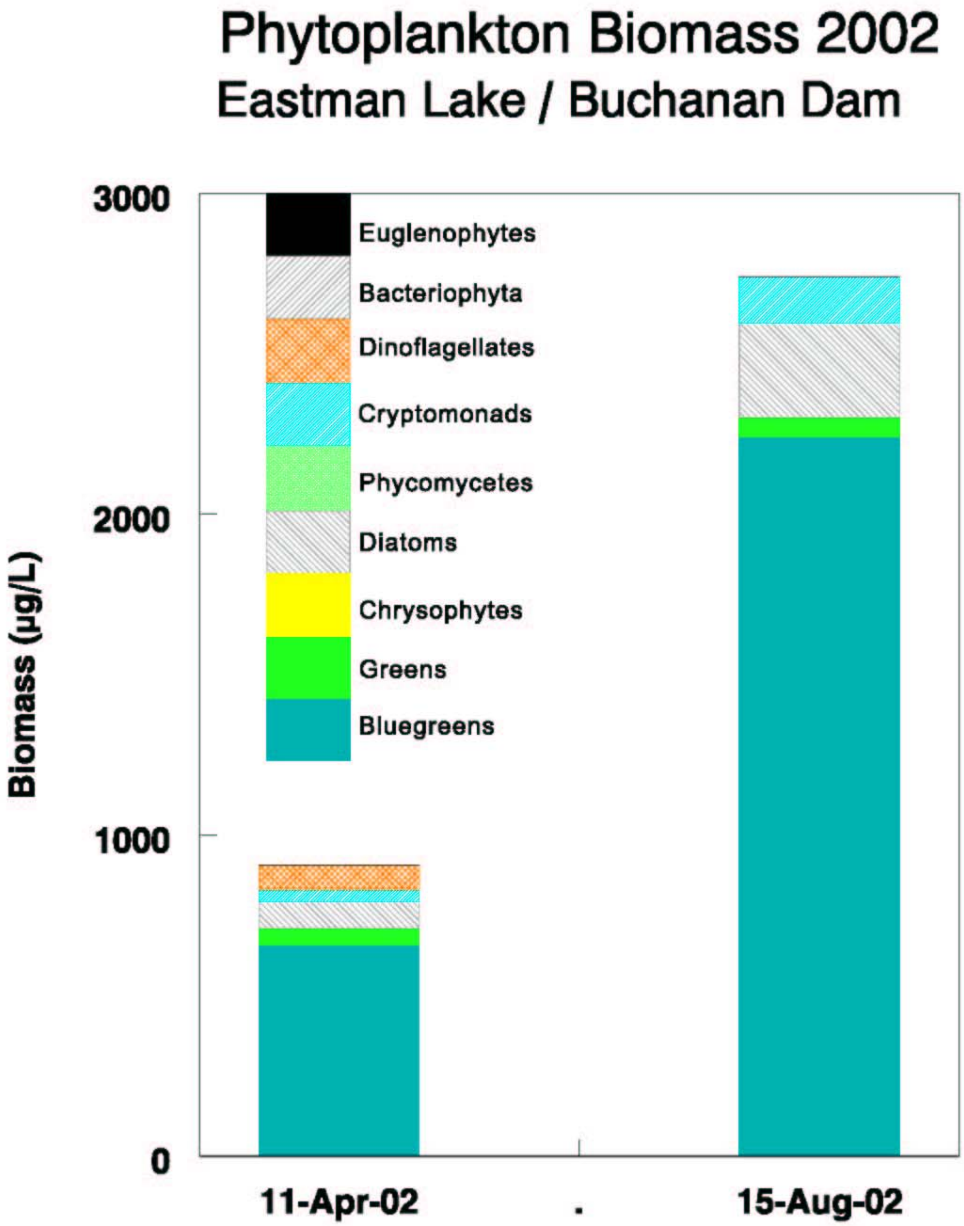


Lake Eastman - pH Profile
Depth (Ft)
0
10
20
30
40
50
60
70
80
90
6.00
6.50
7.00
7.50
8.00
8.50
9.00
pH
April
August

EASTMAN					
Sample Location: Behind dam				**Date:** 04/11/02	
Observers: Tim McLaughlin				**Time:** 9:30 am	
Lake Elevation: 499.04					
Weather Conditions:					
Wind Speed: 0		**Precipitation:** 0		**Temp (F):** 65	
SECCHI Depth: 10 feet and 2 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
25.1	85.3	10.37	154	3.18	7.77
24	78.7	10.38	154	3.21	7.77
22	72.2	10.40	154	3.27	7.78
20	65.6	10.41	153	3.46	7.79
18	59.1	10.45	154	3.29	7.80
16	52.5	10.53	152	4.89	7.80
14	45.9	10.62	152	5.01	7.79
12	39.4	10.75	153	5.09	7.81
10	32.8	11.29	152	6.46	7.81
8	26.2	11.95	151	8.45	7.81
6	19.7	14.15	152	10.40	7.79
4	13.1	18.30	152	11.02	7.80
2	6.6	19.20	154	11.03	7.79
0.03	1	19.50	154	11.08	7.78
CHOWCHILLA (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
72.2	7.84		-	-	-
VISUAL OBSERVATIONS: Algae-like material in water.					

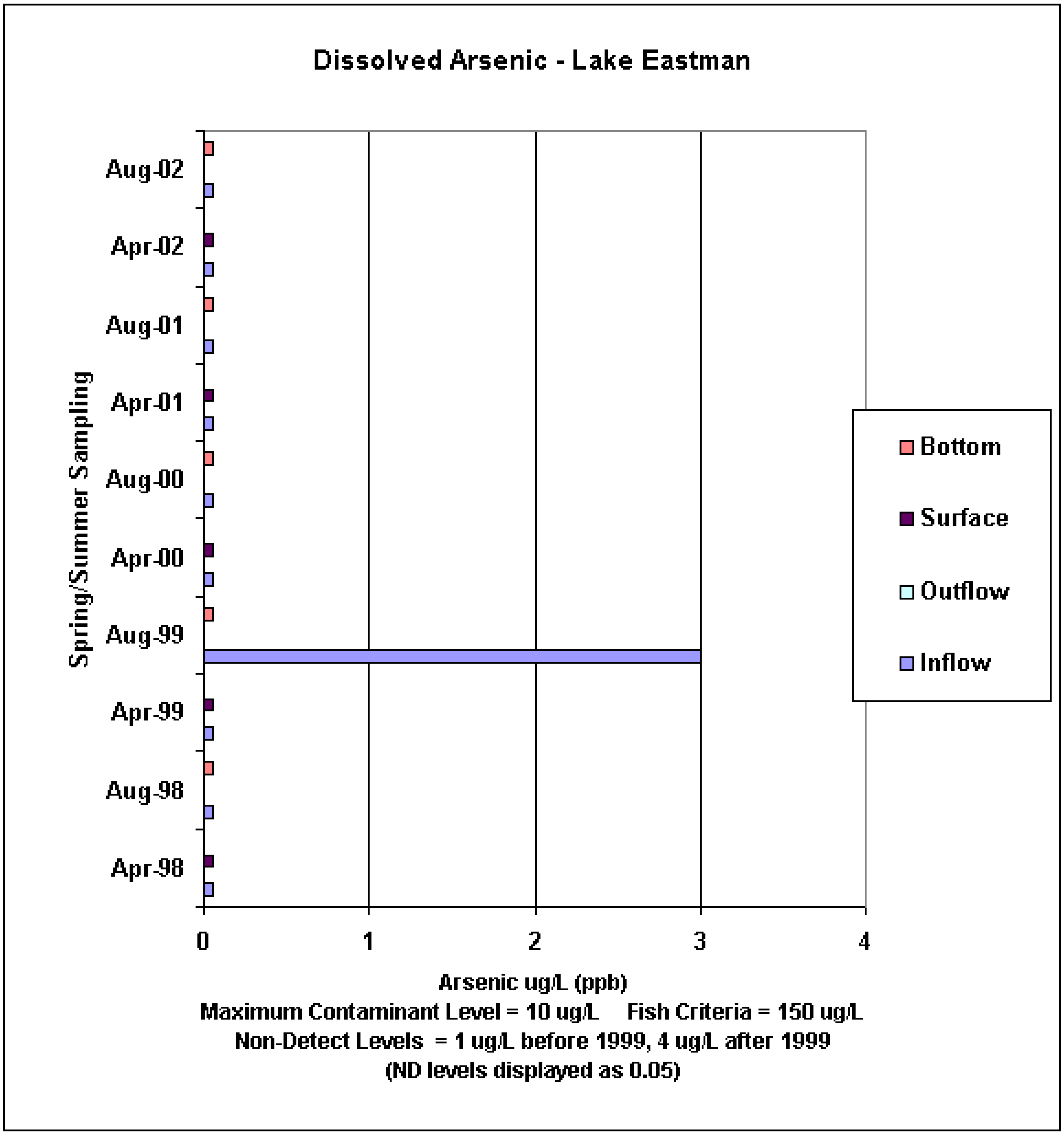
EASTMAN					
Sample Location: Behind dam				**Date:** 08/15/02	
Observers: Tim McLaughlin				**Time:** 9:50 am	
Lake Elevation: 470.55					
Weather Conditions:					
Wind Speed: 5		**Precipitation:** 0		**Temp (F):** 75	
SECCHI Depth: 1 foot and 10 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
17.3	59.1	23.86	238	0.87	6.96
16	52.5	23.80	236	1.00	7.10
14	45.9	24.16	235	1.33	7.38
12	39.4	24.43	233	1.62	7.51
10	32.8	24.95	231	2.03	7.73
8	26.2	25.12	230	2.96	7.93
6	19.7	25.58	229	4.11	8.22
4	13.1	26.24	226	4.57	8.42
2	6.6	26.36	226	4.82	8.37
0.03	1	26.62	225	5.12	8.37
CHOWCHILLA (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
79.1	7.77		-	-	-
VISUAL OBSERVATIONS: Haif-like algae, hydrogen sulfide smell.					

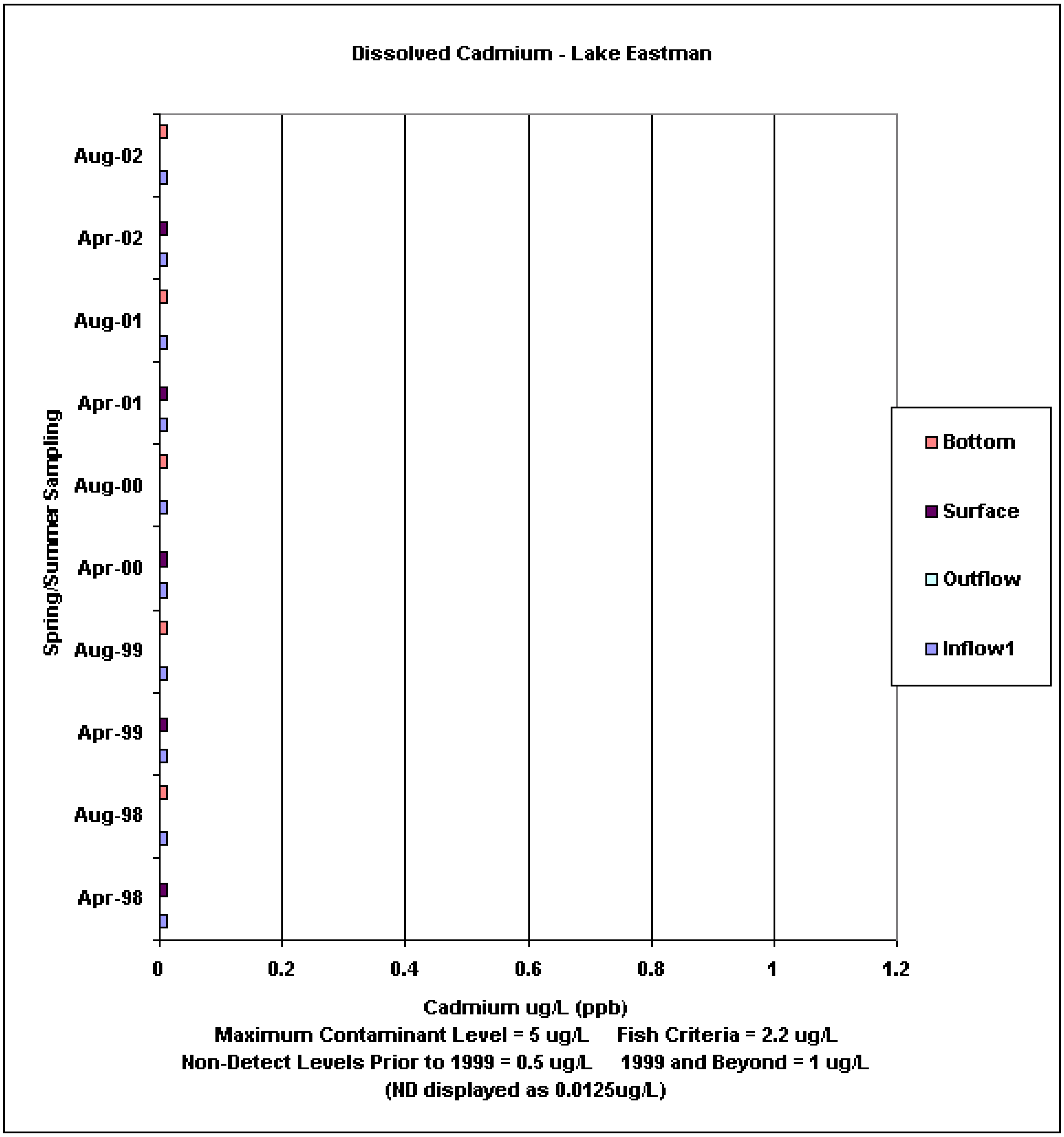
Appendix C: Phytoplankton Data and Charts



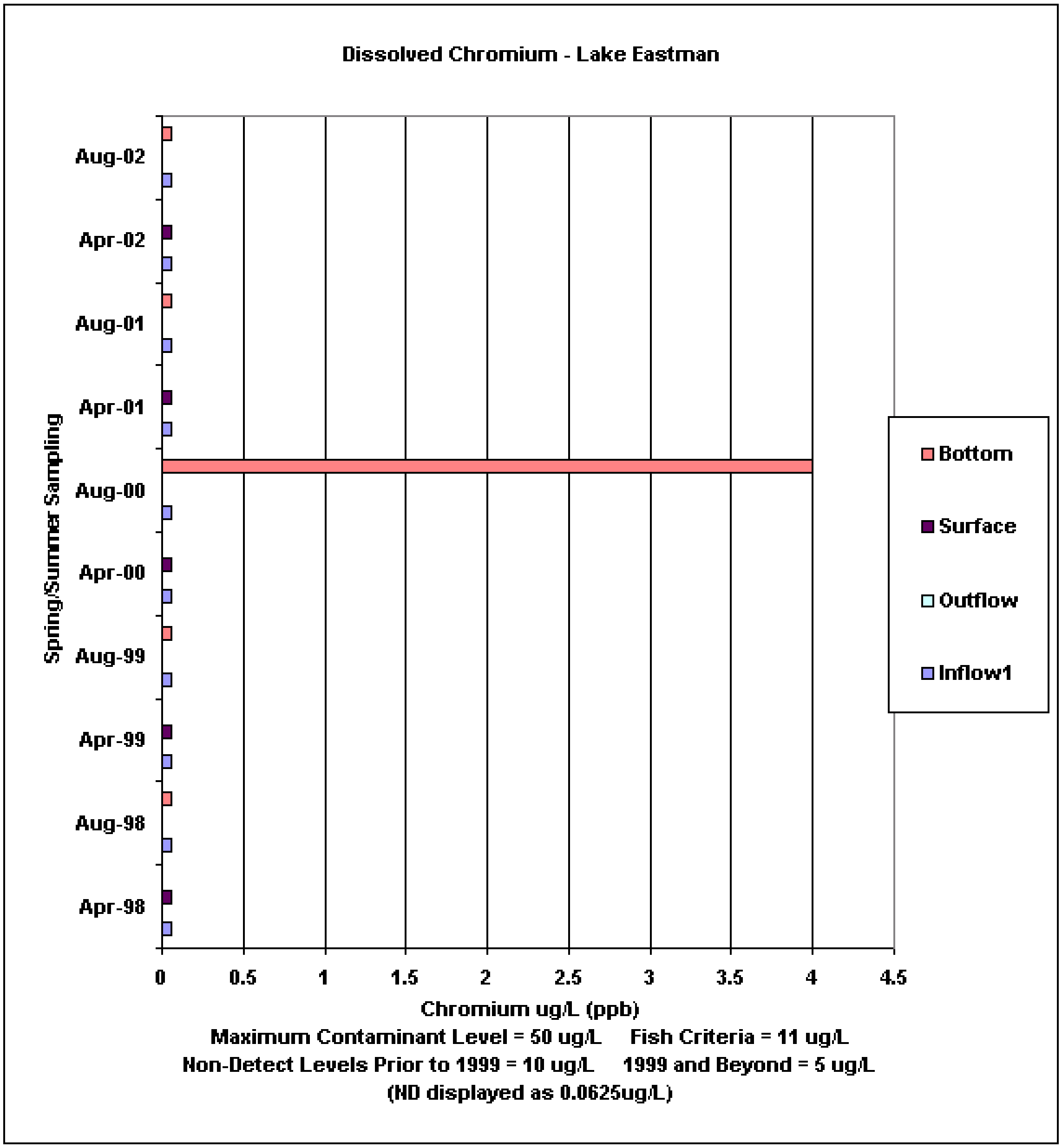
Phytoplankton Biomass 2002
Eastman Lake / Buchanan Dam
Biomass (µg/L)
3000
2000
1000
0
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
11-Apr-02
15-Aug-02

Appendix D: Metals Data and Charts

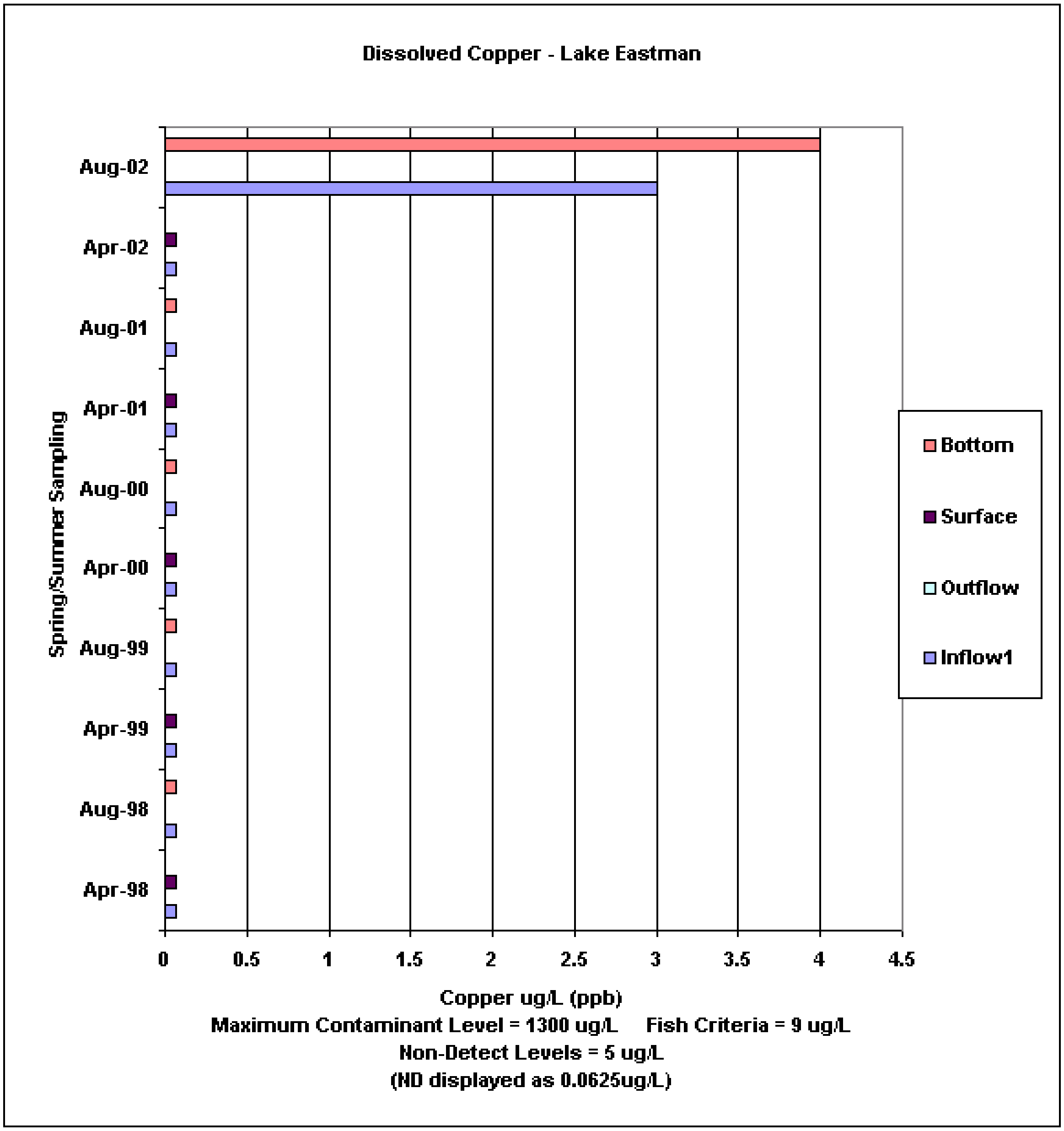

Dissolved Arsenic - Lake Eastman
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
1
2
3
4
Bottom
Surface
Outflow
Inflow
Arsenic ug/L (ppb)
Maximum Contaminant Level = 10 ug/L Fish Criteria = 150 ug/L
Non-Detect Levels = 1 ug/L before 1999, 4 ug/L after 1999
(ND levels displayed as 0.05)



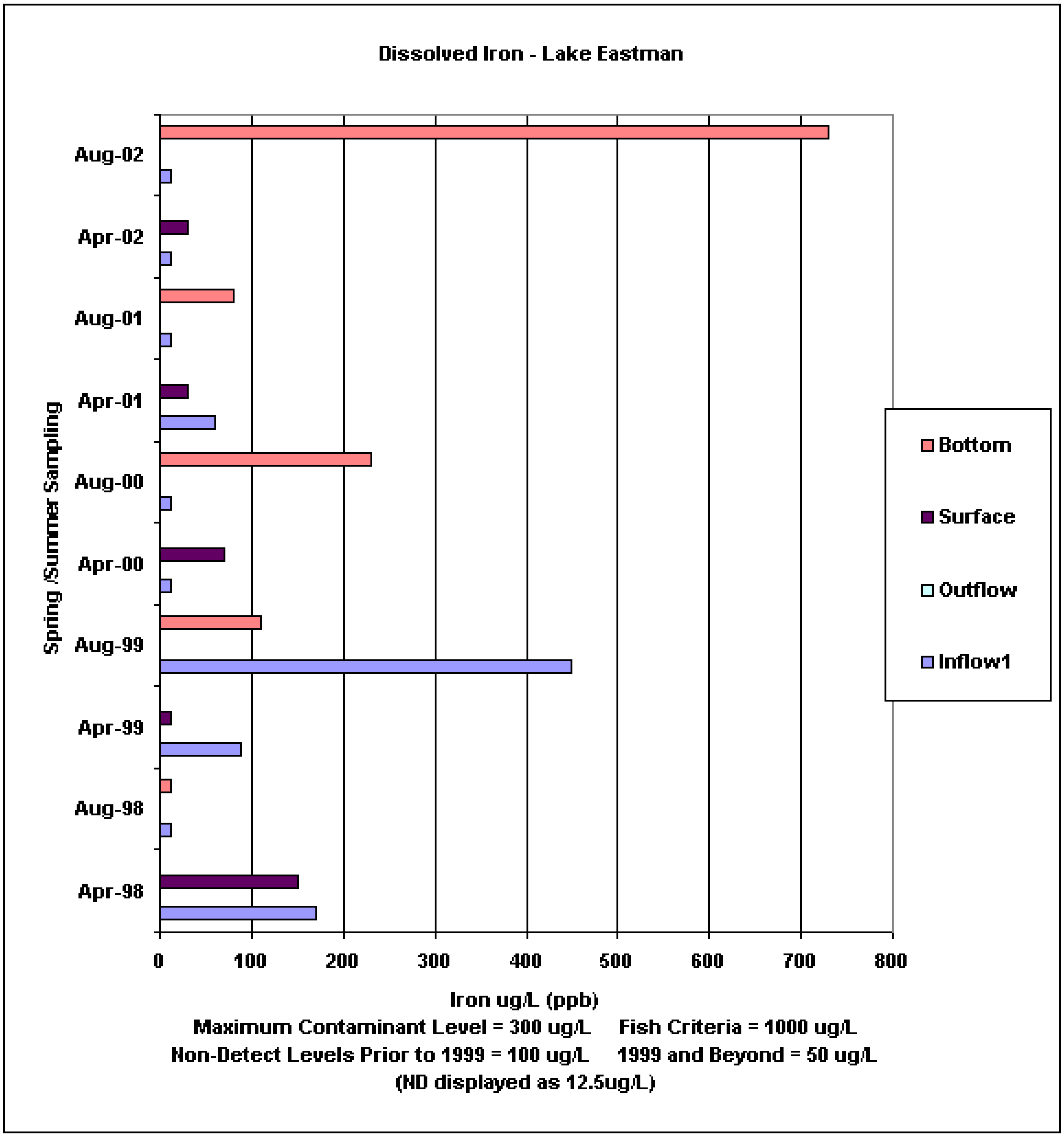
Dissolved Cadmium - Lake Eastman
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.2
0.4
0.6
0.8
1
1.2
Cadmium ug/L (ppb)
Maximum Contaminant Level = 5 ug/L Fish Criteria = 2.2 ug/L
Non-Detect Levels Prior to 1999 = 0.5 ug/L 1999 and Beyond = 1 ug/L
(ND displayed as 0.0125ug/L)
Bottom
Surface
Outflow
Inflow1

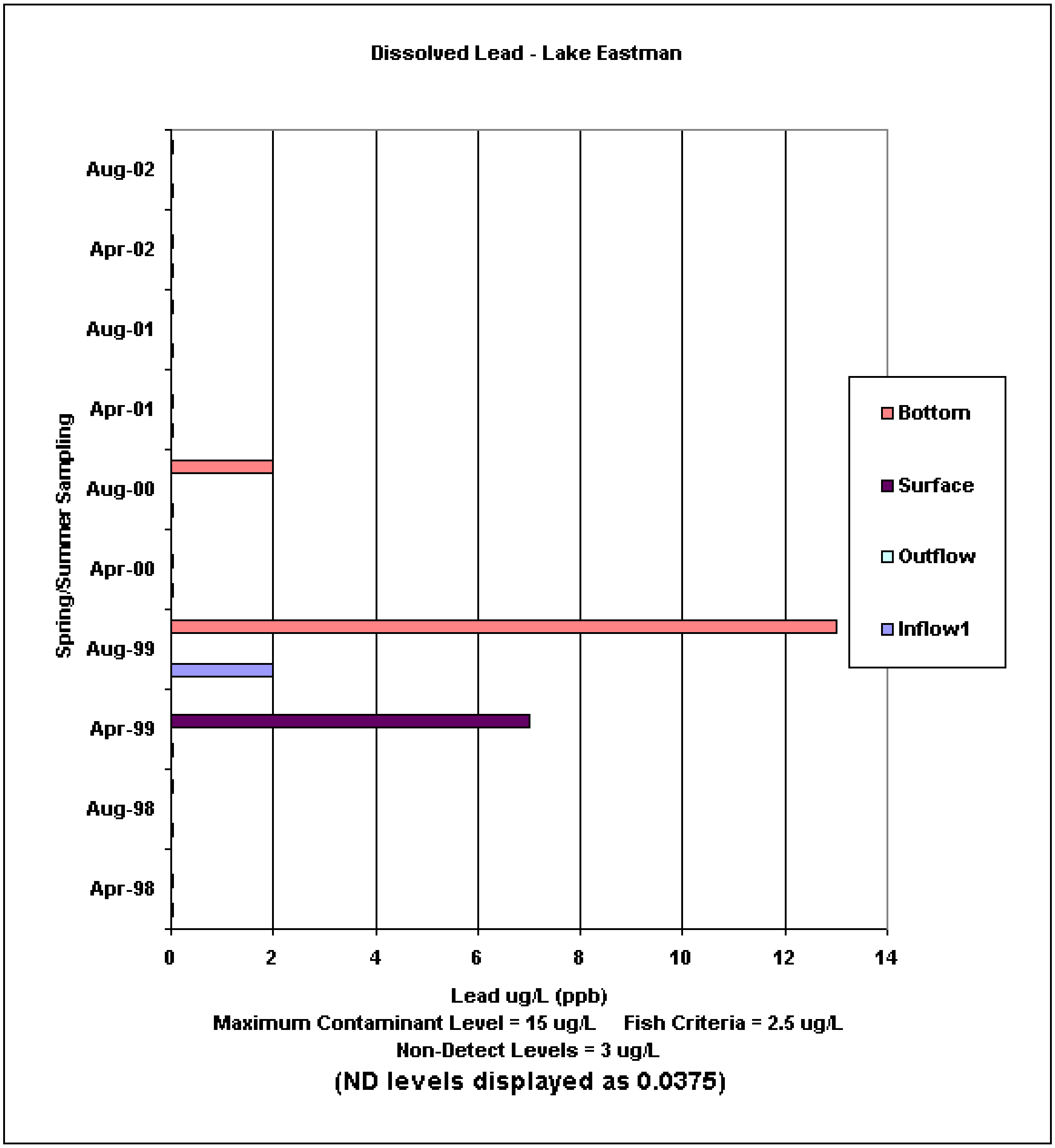


Dissolved Chromium - Lake Eastman
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Bottom
Surface
Outflow
Inflow1
Chromium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L   Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L   1999 and Beyond = 5 ug/L
(ND displayed as 0.0625ug/L)

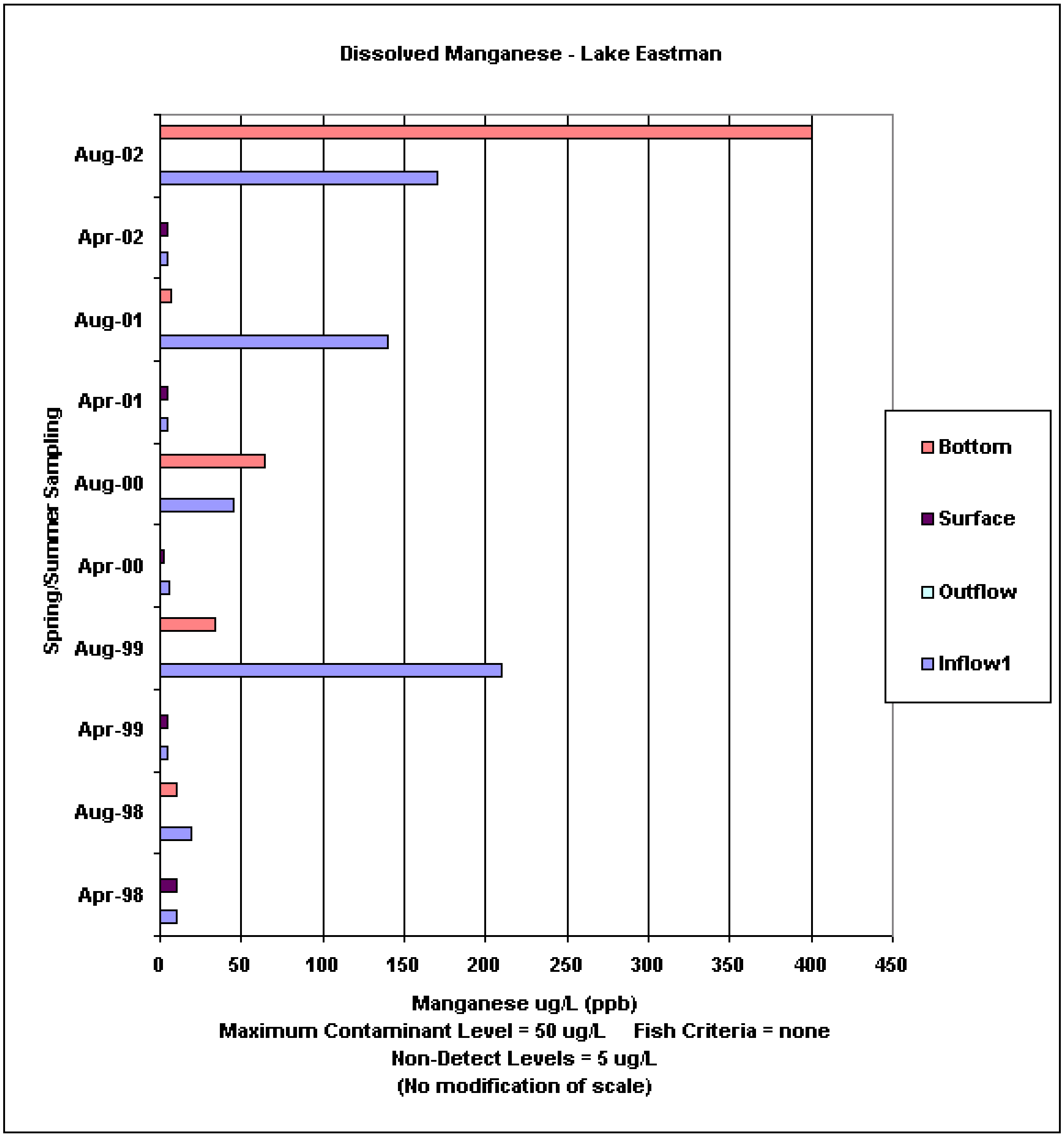


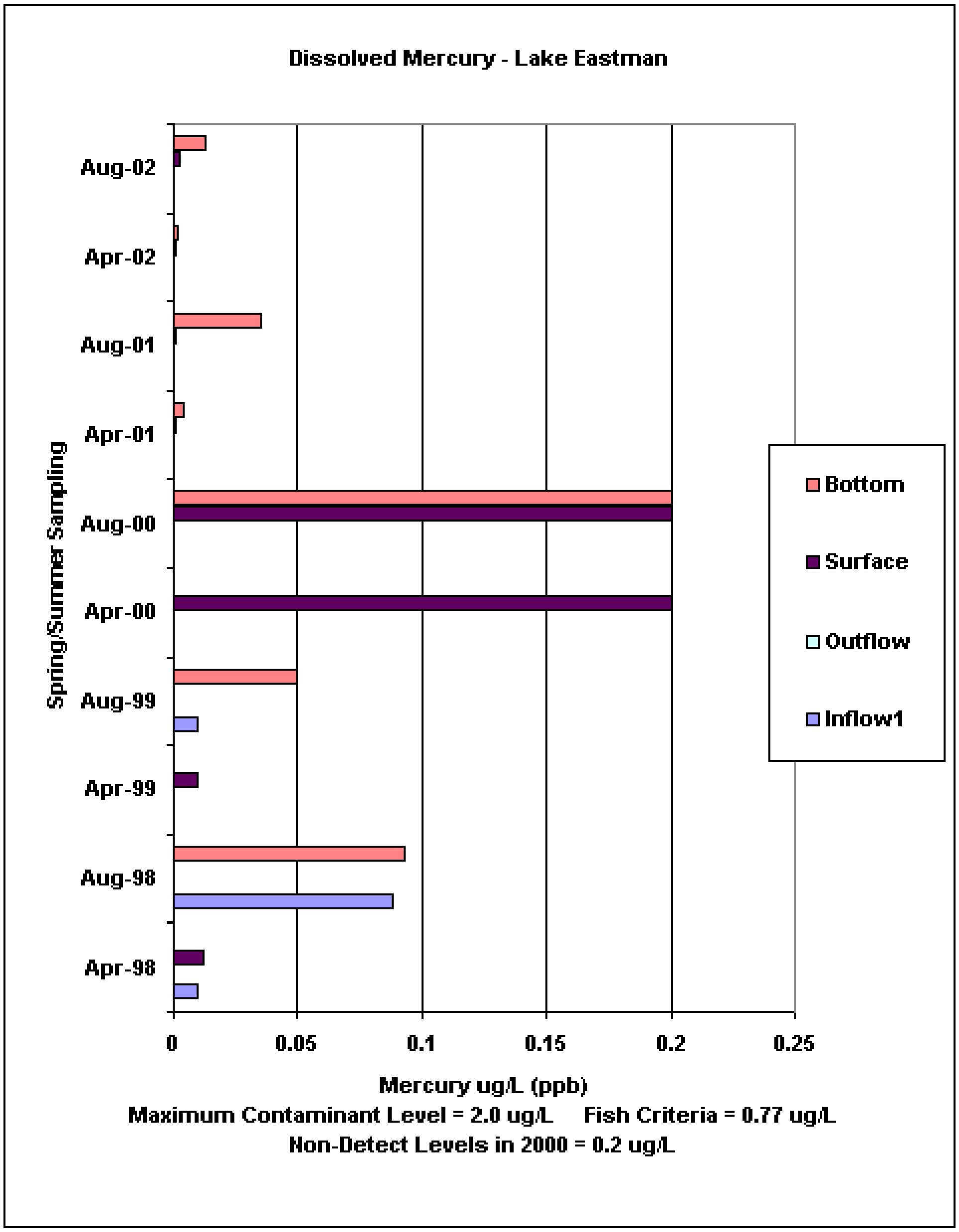
Dissolved Copper - Lake Eastman
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Bottom
Surface
Outflow
Inflow1
Copper ug/L (ppb)
Maximum Contaminant Level = 1300 ug/L Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L
(ND displayed as 0.0625ug/L)


Dissolved Iron - Lake Eastman
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring /Summer Sampling
0
100
200
300
400
500
600
700
800
Bottom
Surface
Outflow
Inflow1
Iron ug/L (ppb)
Maximum Contaminant Level = 300 ug/L   Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L   1999 and Beyond = 50 ug/L
(ND displayed as 12.5ug/L)

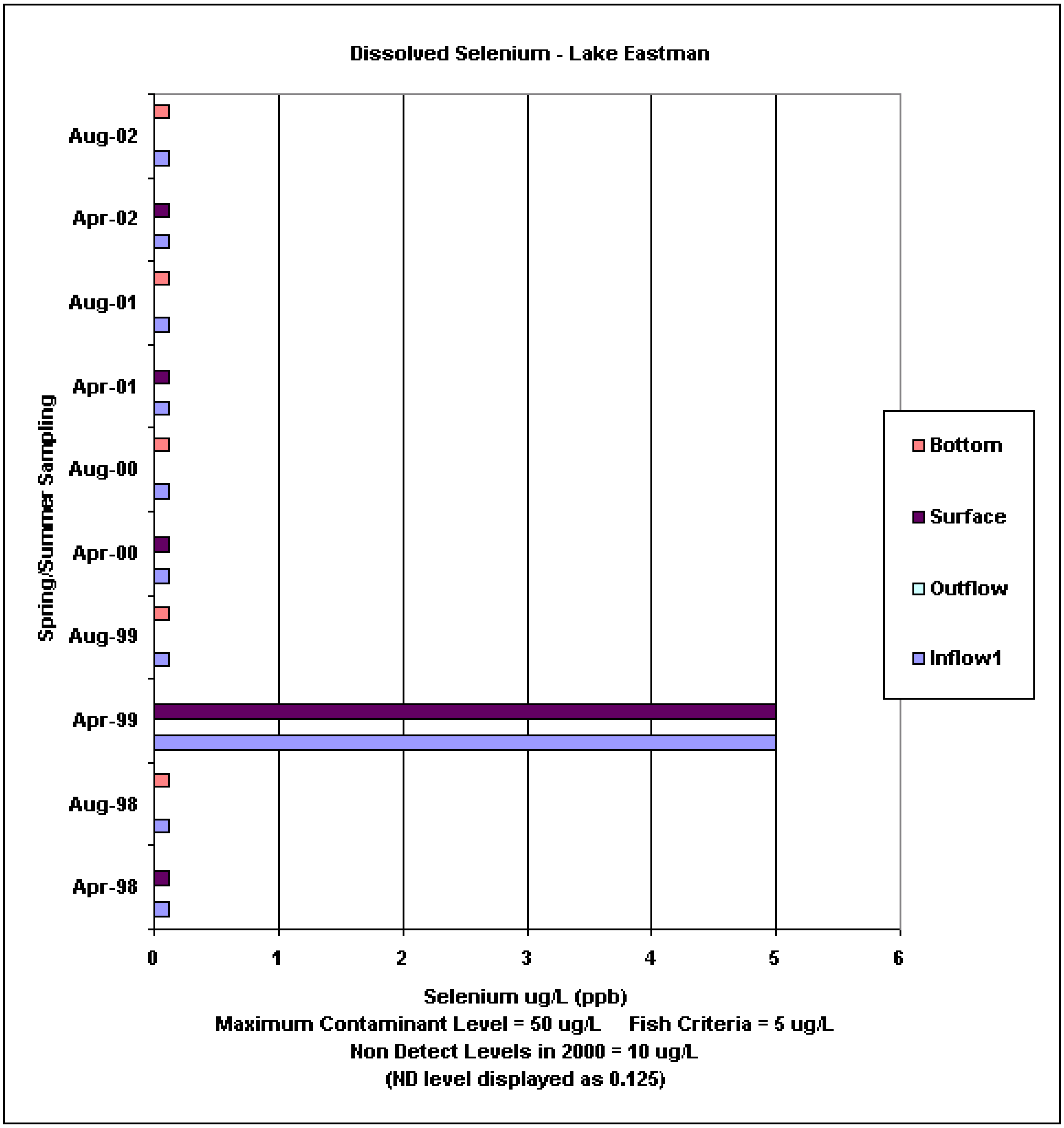


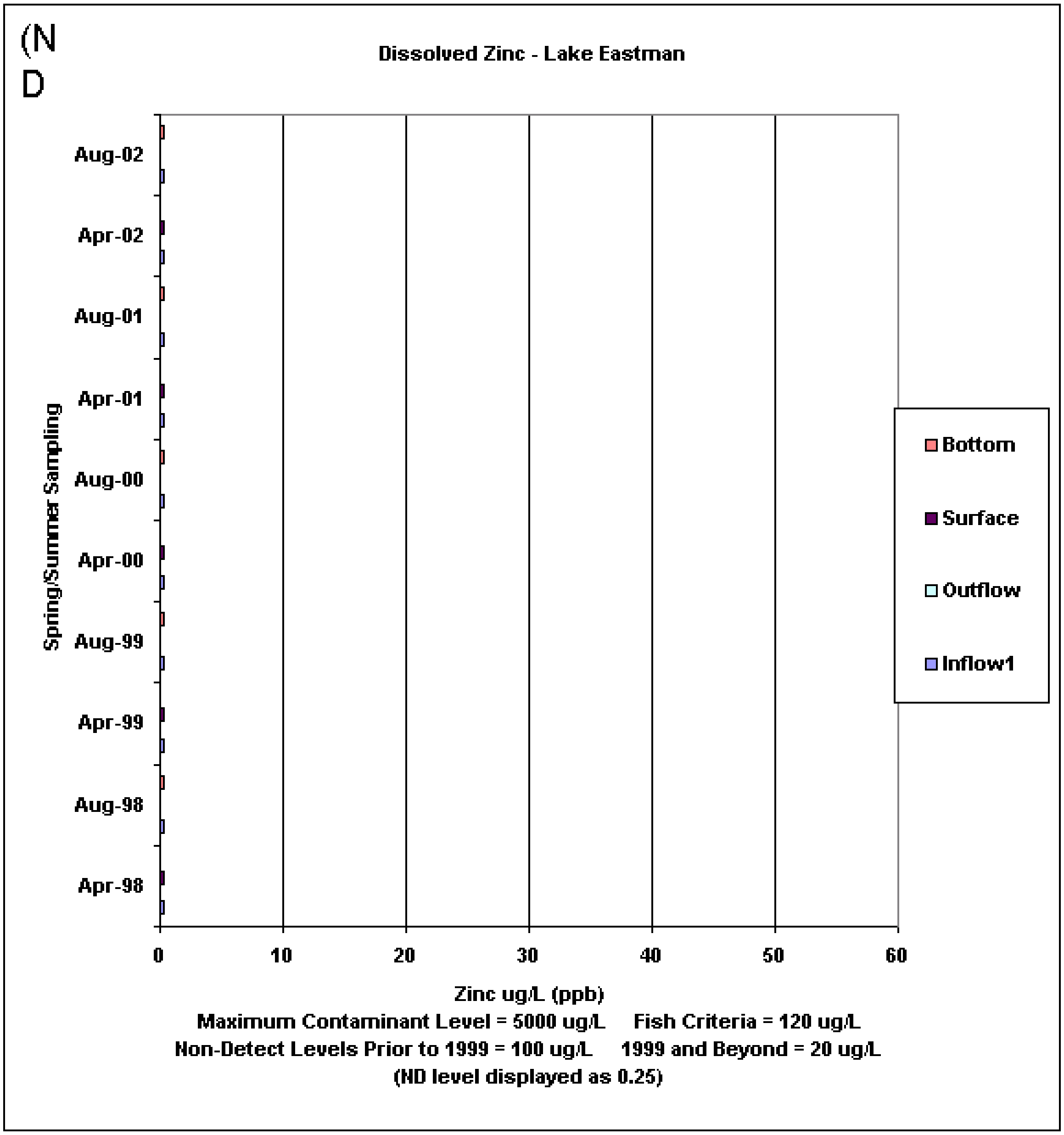
Dissolved Lead - Lake Eastman
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
10
12
14
Bottom
Surface
Outflow
Inflow1
Lead ug/L (ppb)
Maximum Contaminant Level = 15 ug/L
Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L
(ND levels displayed as 0.0375)


Dissolved Manganese - Lake Eastman
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
50
100
150
200
250
300
350
400
450
Manganese ug/L (ppb)
Maximum Contaminant Level = 50 ug/L
Fish Criteria = none
Non-Detect Levels = 5 ug/L
(No modification of scale)
Bottom
Surface
Outflow
Inflow1



Dissolved Mercury - Lake Eastman
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
0.05
0.1
0.15
0.2
0.25
Mercury ug/L (ppb)
Maximum Contaminant Level = 2.0 ug/L
Fish Criteria = 0.77 ug/L
Non-Detect Levels in 2000 = 0.2 ug/L
Bottom
Surface
Outflow
Inflow1


Dissolved Selenium - Lake Eastman
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
1
2
3
4
5
6
Bottom
Surface
Outflow
Inflow1
Selenium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L
Fish Criteria = 5 ug/L
Non Detect Levels in 2000 = 10 ug/L
(ND level displayed as 0.125)


(N
D
Dissolved Zinc - Lake Eastman
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
10
20
30
40
50
60
Bottom
Surface
Outflow
Inflow1
Zinc ug/L (ppb)
Maximum Contaminant Level = 5000 ug/L   Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L   1999 and Beyond = 20 ug/L
(ND level displayed as 0.25)

Appendix E: Inorganic Sample Data

Inorganic Results (mg/L) For surface lake waters (spring)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity		60	40	50	60	30	40	70	80	20		100
Ammonia		<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Chloride		21	2	21	4	4	3	<1	6	5		4
Nitrate		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1		<0.1
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Sulfate		5.3	2.6	4.2	8.9	2	1	8.2	9	2.1		4.7
Kjeldahl N		0.6	0.1	0.4	0.2	<0.1	0.3	0.2	0.2	0.2		<0.1
COD					<50							
Tot Solids		120	70	100	110	60	78	100	120	21		150

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	100	70	40	50	20	30	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	13	25	3	21	<1	<1	4	<1	6	4	3	2
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	
Sulfate	18	2.1	2.3	3	2.8	1.9	0.8	8.8	11	1.6	11	3.5
Kjeldahl N	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1
COD	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	170	130	59	110	60	60	90	110	150	30	130	90

Inorganic Results (mg/L) For surface lake waters (summer)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	140	70	40	50	50	40	70	90	80	10	80	110
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
Chloride	16	26	4	19	6	5	5	5	9	3	5	8
Nitrate	<0.1	1.5	<0.1	1.3	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1
Total P	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	16	4.1	3.6	3.5	5.9	2	0.7	7.4	14	1.6	6.4	4.4
Kjeldahl N	<0.1	2.7	<0.1	0.4	0.4	0.3	<0.1	0.2	<0.1	<0.1	0.2	0.6
COD	<50	60	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	200	190	50	120	98	80	80	120	120	52	100	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	90	40		60	40	80	100	130	20	110	180
Ammonia												
Chloride	16	490	5		10	8	3	5	14	4	5	22
Nitrate												
Total P												
Ortho P												
Sulfate	16	4.5	3		9.8	3.2	<0.5	6	14	2.7	5.4	8.7
Kjeldahl N												
COD												
Tot Solids	200	1300	50		140	100	100	150	200	50	140	280

Appendix F: MTBE Table

2002 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2002 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	2		2		<2		<2		
Eastman	5				<2				
Englebright	3		3		10		10	10	
Hensley	3		3		3		3		
Isabella	<2	<2	<2	<2	<2	<2	<2	<2	
Kaweah	2		2	<2	8		6	6	
Martis Cr.	<2				<2				
Mendocino	<2				<2				
New Hogan	<2				3				
Pine Flat	<2		<2		2		2		
Sonoma		3	<2		<2		2		
Success	4		4	4	11	12	11	11	

Notes:

1. Non-Detect is indicated by "<2" since the Reporting Limit is 2 ppb or 0.002 ppm.
2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.
3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.
4. For 2002, the number of MTBE water sampling at each lake is based on last year's lab results.
5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was historically non-detectable. The 2002 results of non-detectable levels were similar except Lake Eastman and New Hogan now reported low, detectable levels of MTBE.
6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because of historically low detectable levels of MTBE.
7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because of historically higher MTBE being found. The 2002 results were similar except Isabella now reported non-detectible levels.
8. In 2001, very high MTBE levels were reported at Lake Isabella during the Spring (18 ug/L near the marina) . During Spring 2000, Lake Isabella reported 21 ug/L. The 2002 results indicate that the previous MTBE problem near the marina was not visible during the Spring 2002 sampling event, and may have been rectified.

G. Fish tissue analysis table

2002 Fish Tissue Results

The following table provides an overview of the lab results for the 2002 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conductng the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The California OEHHA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Mercury Total ppm	FDA Criteria
Black Butte	Sm M Bass	Composite (3)	6/12/02	0.24	0.26	1 ppm
Eastman	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Englebright	Note 5	N/A	N/A	N/A	N/A	
Hensley	Black Bass	Composite (3)	4/23/02	<0.10	0.72	1 ppm
Isabella	Black Bass	Composite (3)	6/4/02	0.20	0.21	1 ppm
Kaweah	Sm M Bass	Composite (3)	7/14/02	0.11	0.53	1 ppm
Martis Cr	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Mendocino	Note 6	N/A	N/A	N/A	N/A	
New Hogan	Lg M Bass	Single (1)	6/3/02	<0.10	0.34	1 ppm
Pine Flat	Note 4	--------------------	-----------	----------	-----------	< Mon 01
Sonoma	Note 6	N/A	N/A	N/A	N/A	
Success	Black Bass	Composite (3)	4/15/02	<0.10	0.18	1 ppm

Notes:

9. Non-Detect is indicated by "<0.02". The lab Detection Limit for mercury is 0.02 ppm.
10. Total Mercury was reported in mg/g or ppm.
11. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.
12. The fish tissue program was terminated at Eastman and Martis Creek in 2001 and in Pine Flat in 2002 due to low total mercury results. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout). For Pine Flat total mercury was 0.21 ppm in 2000 (composite of three Sacramento Sucker fish) and 0.23 in 2001 (composite of three spotted bass).
13. Due to seasonal conditions, a fish could not be successfully collected at Lake Englebright. Another attempt will be accomplished for the 2003 report.
14. Fish were not collected at Mendocino or Sonoma due to communication difficulties.

The above 2002 total mercury results indicate only Hensley is higher than average. However, in 2001, the total mercury results were only 0.30 ppm for Hensley (small mouth bass). The 2003 fish tissue program should provide additional data. EPA fact sheet on fish advisories (EPA-823-F-99-016) indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.

Annual Water Quality Report

ENGLEBRIGHT LAKE

Water Year 2002

Written by
John J. Baum
Water Quality Engineer
U. S. Army Corps of Engineers
Sacramento District
January 2003

TABLE OF CONTENTS

Englebright Lake

I. Purpose

This report is part of an environmental monitoring program that began at Englebright Lake in May 1991. The monitoring program was implemented to ensure a continuous level of water quality in the lake for both recreation and environmental, and to satisfy the Department of Army Engineering Regulation 1110-2-8154, “Water Quality and Environmental Management for Corps Civil Works Projects”.

II. Brief Description of Englebright Lake

Englebright Lake is located in central California, 21 miles east of Marysville. It is nestled in the Sierra Nevada foothills and is surrounded by grasslands and blue oaks. Englebright Lake was constructed for the storage of hydraulic gold mining debris. Englebright Dam is a concrete arch structure that spans 1,142 feet across and is 260 feet high. The dam is in the steep Yuba River gorge known as the Narrows, holding back a 9-mile long lake with a surface area of 815 acres. The lake has become a popular destination for recreation and has camping areas only accessable by boat.

Some characterization sampling was performed between 1975 and 1976 prior to the newer monitoring program. Generally there are two sample events a year, spring (April) and late summer (August). Since the start of the monitoring program, a water quality report is produced yearly to list results and address any concerns of the previous water year.

Generally Englebright Lake has a depth of greater than 150 feet during the sampling events, and is considered an oligotrophic lake when characterized by its clarity. Oligotrophic lakes are characterized by their higher and limited nutrient availability. An example of an oligotrophic lake is Lake Tahoe. On the opposite end of the spectrum are eutrophic lakes, which are characterized by their low clarity and higher nutrient concentrations. Mesotrophic lakes are those that have characteristics in between oligotrophic and eutrophic lakes. Most of the lakes monitored by the USACE are either eutrophic or mesotrophic, Englebright Lake is the only oligotrophic lake. Englebright Lake can has relatively high dissolved oxygen conditions (>5mg/L) at its bottom depths during warm late summer months. Because of its depth, Englebright Lake has the ability to stay cool (<20ºC) in the late summer. Due to the low late summer temperatures and the sustained high concentration of dissolved oxygen, coldwater fish species could reliably survive in the lake year round. Coldwater fish various species of trout and salmon. Although clearer than eutrophic (nutrient rich) lakes, oligotrophic lakes can occationally have low water clarity due to algal blooms and suspended sediments. Water clarity is often measured in terms of Secchi Disc depth or SD (Appendix A). Historically, the water clarity in Englebright Lake is good with only ~ 4.8 % of the samples not meeting the recreational goal of 4 feet or greater (Figure 1). In 2001 the Spring SD measure was 16.08 feet and the late summer sample SD value was better at 16.75 feet.

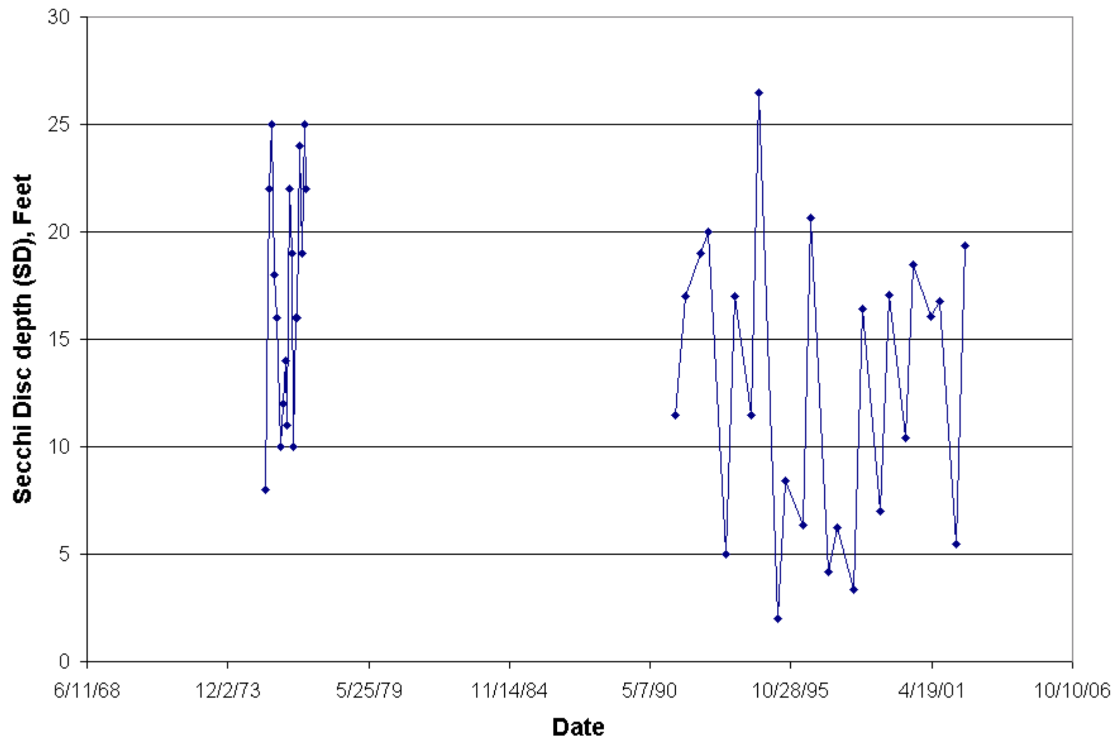


Figure 1. Historical Secchi Depth Values at Pine Flat Lake (2002 values included).

In 1999 the United States Geological Survey (USGS) began studies in and around Englebright Lake to examine levels of mercury contamination in fish. While they found most fish with mercury concentrations above the California Office of Environmental Health Hazard Assessment's (OEHHA) screening level of 0.3 ppm, none of the twenty-one fish they tested were above the FDA criteria for a fish advisory (1 ppm). The highest concentration found was 0.96 ppm mercury in one small mouth bass. The USGS has continued to monitor mercury at Englebright Lake, and are a good resource for future information.

In response to public concern about mercury, a regional television station (KOVR 13, Sacramento, Stockton, and Modesto) performed some investigative sampling for mercury in fish from Englebright Lake. While the trout they captured had relativlely low concentrations of mercury (0.2 ppm mercury), the two bass caught had a concentration of 1.2 ppm. Results from their bass tissue analysis exceed the FDA criteria for a fish advisory (1 ppm).

Fish monitored by the USACE in 2000 and 2001 resulted in concentrations below the OEHHA's screening level to continue monitoring (0.3 ppm mercury). Due to the findings by the USGS and local media, a more detailed sampling program is recommended.

The 2001 Water Quality Report listed only manganese concentrations at the bottom of the lake as a contaminant of concern at Englebright Lake. Since manganese has no fish criteria limit and only a secondary human MCL based on taste and water stains, manganese shouldn't have been listed as a contaminant of concern in previous reports.

III. Sample Summaries for this year.

Introduction

The following general summaries are split into their respective sample types. Each type of sample summary includes a discussion of both the spring (April) and late summer (August) samples to better examine trends within the current year. The types of parameters monitored this year include: Secchi Disc depths, water column profiles (temperature, DO and pH), phytoplankton characterization, metals concentrations, MTBE concentrations, and Inorganic characterization (alkalinity, phosphorous, nitrogen, etc..). Fish mercury concentrations were not obtained in 2002 due to the inability to successfully collect fish. For a more detailed explanation of the importance for each type of sample, please see Appendix A.

SECCHI DEPTH

The Secchi Disc depth (SD) values found during the spring sampling event were lower than the historical mean, while and late summer SD were higher (historical mean SD = 14.63 feet). More often the clarity is better in the late summer than in the spring. In spring the water clarity was low and the SD was 5.5 feet, which was worse than the previous year (2001 Spring SD = 16.08 feet). The late summer SD of 19.33 feet was above the previous years value (Summer 2001 SD = 16.75 feet) (Appendix B).

TEMPERATURE VALUES

The temperature profiles for Englebright Lake are indicative of a well stratified lake. Due to being deep, Englebright Lake is able to retain a cooler bottom water layer (hypolimnion) that buffers the lake from atmospheric temperature shifts. The difference in the depth of the lake between the spring and late summer sampling events was small (spring depth = 190.3 feet, late summer depth= 196.9 feet). Although the temperature of the water near the surface was considerably different (at 1 ft depth: Spring Temp. = 13.70 ºC, Summer Temp. = 20.30 ºC), the average temperatures were similar (spring average temp. = 8.3 ºC, late summer average temp.= 10.3 ºC). Due to having the ability to maintain a cool average temperature during the late summer, Englebright Lake is well suited to support coldwater fish species. For detailed results obtained during the sampling events, please see Appendix B.

DISSOLVED OXYGEN

The dissolved oxygen (DO) concentration don't greatly differ from spring to late summer. In spring, DO concentrations are 11.19 mg/L near the surface and 9.50 mg/L at the bottom of the lake. DO concentrations near the surface are above saturation, which is 10.46 mg/L at 13.7 ºC. The concentration of oxygen near the surface of the lake is above saturation due to aquatic plant photosynthesis. DO concentrations in the late summer are lower than the spring values, but are still at high values (>5 mg/L). During the summer the DO concentration near the surface was 7.82 mg/L and lowered towards the bottom of the lake to a minimum of 7.03 mg/L. Fish species that require greater than 5 mg/l DO at cooler water temperatures (< 20ºC) should be able to survive year-round at Englebright Lake. For detailed results obtained during the sampling events, please see Appendix B.

PH LEVELS

In the spring sample event, pH values in the lake were slightly basic (pH = ~7.7) throughout the water column. The pH values in the late summer profile varied widely. The pH was basic towards the upper waters (max pH = 8.41) and less basic at the bottom (pH bottom = 7.53). The lower pH values at the bottom of the lake increase the likelihood that higher soluble metal concentrations will be seen. For detailed results obtained during the sampling events, please see Appendix B.

PHYTOPLANKTON

In the spring sample, the algal biomass within the lake was similar (Biomass = 165.73 ug/L) to spring 2001 (2001 Spring biomass = 224.56 ug/L). In spring 2001 cryptomonads were the most dominants species and in Spring 2002 diatoms were the most dominant. The late summer phytoplankton biomass was similar in 2002 (2002 Summer Biomass = 44.05 ug/L) and 2001 (2001 Summer Biomass = 63.88 ug/L). Several species were visible in the summer sample with the dinoflagellates the most numerous. For detailed results obtained during the 2002 sampling events, please see Appendix C.

METALS

Two samples exceeded the maximum contaminant level (MCL) or the freshwater fishery criteria for dissolved lead and manganese during either the 2002 spring and summer sampling events. An elevated concentration of lead (2.6 ppb) was found in a sample of water flowing into the lake. The concentration of lead in the sample was estimated to be greater than the suggested aquatic life continuous concentration of 2.5 ppb. Manganese concentrations continue to remain high near the bottom of the lake. A value of 100 ppb Mn was found at the bottom of the lake during the 2002 late summer sampling event. Since manganese has no fish criteria limit and only a secondary human MCL (50 ppb) based on taste and water stains, manganese isn't a contaminant of concern in Englebright Lake.

Contaminants will continue to be monitored in the coming year for any changes. For detailed results obtained during the sampling events, please see Appendix D.

MTBE

Concentrations for MTBE around the lake increased from the spring to the late summer sampling events. MTBE concentrations around the lake were found to be 3 ppb during the spring, but then increased to 10 ppb during the late summer. No health impacts have been associated with concentrations of MTBE similar to those found in the lake. For detailed results obtained during the sampling events, please see Appendix F.

INORGANIC ANALYSIS

The spring and summer sample results were within expected ranges and levels. For detailed results obtained during the 2002 sampling events, please see Appendix E.

IV. Conclusions

Englebright Lake is a deep stratified oligotrophic lake that can comfortably support many fish species. Coldwater fish that require temperatures below 20°C and dissolved oxygen concentrations greater than 5 mg/L should do well in the lake. Water clarity in Englebright Lake during the 2002 sampling events was well above the 4 feet recreational goal.

In the 2002 Englebright Lake sampling events lead was found to exceed the aquatic health limit for fish. A high lead concentration (2.6 ppb) was found in water flowing into Englebright Lake.

During the late summer sampling event, higher concentrations of MTBE (10 ppb) were found in lake samples. While no health issues are associated with the concentration, the value is worth noting for future concerns.

Due to the recent concerns about mercury within Englebright Lake, an increased effort will be made to collect fish out of the lake for analysis. Although the USACE aquatic mercury concentrations over the last several years have been low, USGS and local media results have indicated an ongoing problem. A more detailed fish monitoring program is recommended for Englebright Lake. Additionally, greater effort should also be made to coordinate with USGS personnel doing research at the lake.

V. References

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VI. Appendices

Appendix A: Glossary of Sample Types

Glossary of Sample Types

This glossary of sample types is intended to provide a general background and indicate the importance of each sample in determining water quality. These are meant to be brief and basic. If a further explanation is desired please refer to the list of references provided in this report.

Secchi Depth

One of the oldest and easiest methods to determine lake clarity is the Secchi depth (SD). The Secchi depth is determined by dropping a Secchi disc into a water body and determining the depth that it is last visible from the surface of the water. Secchi discs are generally white and 20 cm in diameter. Secchi depth values are most impacted by the light intensity at the time of sampling and the scattering of light by solid particulates within the water column. Algal growth (phytoplankton) and sediment re-suspension are often major constituents of solid particulates within the water column. Secchi depth values can be used to estimate the Trophic state or the nutrient levels within the lake. The more nutrients are available, the larger likelihood of algal blooms that limit water clarity. Due to recreational concerns for safety, the goal for Secchi depth values is four feet or greater.

Temperature Profiles and Data Points

The temperature profile of a lake provides information how a lake is operating and the potential for aquatic biota to live within the lake. The temperature profile is a direct indicator if a lake is stratified. Stratification in lakes is created generally by temperature affecting the density of water molecules. Stratification is usually indicated by a region of similar temperature nearer the surface of the water (epilimnion), then a region of temperature transition (metalimnion), to another layer of nearly constant temperature at the bottom of the lake (hypolimnion). Each layer in a stratified lake is important, but the existence of a hypolimnion can drastically impact how well a lake can handle warmer temperatures such as those found in northern California during the summer. The hypolimnion acts as a buffer against large temperature shifts. The nature of dam operation is that water is discharged near the bottom, releasing the hypolimnion, and eliminating stratification. This operation limits the ability of reservoirs to regulate their temperature during the summer months. Stratification isn't always desirable. When a lake isn't stratified and is instead well mixed, the required nutrients near the bottom of the lake become available to phytoplankton for growth. Temperatures within lakes also indicate which species of fish will survive within a lake. Coldwater species of fish require temperatures below 20 degrees C in order to spawn and survive. If a lake is often above 20 degrees C, then only warmwater fish species will survive.

Dissolved Oxygen (DO) Concentration Profiles

DO is required by organisms for respiration and for chemical reactions within lake waters. The recommended level for DO for most aquatic species survival is 5mg/L. In lakes, biota waste (detritus) falls to the bottom of the lake to be utilized by bacteria. The bacteria need oxygen and will deplete levels near the bottom of a lake, especially during

warm temperature, high respiration conditions. For nutrient rich (eutrophic) lakes more organisms will grow, create wastes, and cause oxygen depleted regions at the lowest areas. Under these conditions only aquatic species that can survive low DO conditions in warm water near the surface will survive.

PH Profiles

The pH profiles of the lakes indicate the potential for certain chemical reactions to occur. In high pH (greater than pH = 7 or basic) aquatic systems, metal pollutants tend to form into insoluble compounds that fall onto the lake floor. In low pH (less than pH = 7 or acidic) systems or areas metal ions become soluble and available for uptake into aquatic organisms. Other compounds like ammonia that are introduced into a low pH aquatic environment will transform into soluble nitrate and be utilized by organisms.

Phytoplankton Analysis

Phytoplankton analysis indicates the health, nutrients, and biodiversity within a lake. Lakes that have few nutrients available (Oligotrophic) will generally have a much lower quantity of phytoplankton (high Secchi depth) but the number of phytoplankton species seen will be large. In a lake that is nutrient rich (eutrophic) there are generally large phytoplankton blooms (low Secchi depth), but they are made up of a couple of phytoplankton species. Certain species of phytoplankton are preferred food sources for zooplankton (small invertebrates). Generally species like diatoms and green algae can be consumed by the filter-feeding zooplankton, but species like bluegreen algae are low in nutrients and are difficult to consume. Some species like the dinoflagellates can grow horn like points to discourage potential predators. In nutrient rich waters where there is plenty of phosphorous, nitrogen can be limited for biological growth. While most species can’t grow due to the lack of nitrogen, bluegreen algae (cyanobacteria) have the ability to utilize nitrogen from the atmosphere when required. This gives bluegreen algae the ability to dominate in many eutrophic lakes.

Soluble Metals Analysis

The soluble metals analysis indicates the exposure of humans and aquatic organisms to toxic metals. These metals often build up as they are consumed through the food chain. Water samples provide an indicator for additional problems. Soluble forms of metal ions are more prevalent in low pH (pH <7, or acidic) environments.

MTBE Analysis

MTBE (methyl tertiary-butyl ether) is a chemical additive to gasoline to improve combustion. Due to its high solubility, MTBE travels and blends into aquatic systems rapidly. While not found to be extremely hazardous at low levels, the offensive smell and taste is detectible by humans at extremely low concentrations. The effect of MTBE on humans and aquatic systems is still under investigation.

Inorganic Analysis

Alkalinity

Alkalinity is measured in terms of mg/L of calcium carbonate. It indicates a lakes ability to buffer incoming acidic pollution and situational changes.

Ammonia

Ammonia is a gas that is toxic to fish and is more visible at a higher pH. Ammonia is created through anthropogenic inputs, bacteria cell respiration, and the decomposition of dead cells. Due to being a gas, given time ammonia will volatilize from the water. At a lower pH, much of the ammonia is converted to ammonium (a nutrient for root bound plant life) and utilizes DO in the nitrification process.

Chloride

The chloride ion is an indicator of any salinity increases within a lake. Most fresh water aquatic species are sensitive to salinity changes.

Nitrate

Nitrate is the nitrogen product created through the nitrification of ammonium. Nitrate is a soluble form of the nutrient nitrogen and is utilized by phytoplankton.

Total Phosphorous

The total phosphorous provides a measure of both utilized and soluble phosphorous within water samples. Phosphorous is a required nutrient for plant growth and development.

Ortho Phosphorous

Ortho phosphorous is the soluble form of phosphorous that is utilized by free-floating aquatic plants (phytoplankton).

Kjeldahl N

Kjeldahl nitrogen or total Kjeldahl nitrogen (TKN) is a measure of the total concentration of nitrogen in a sample. This includes ammonia, ammonium, nitrite, nitrate, nitrogen gas, and nitrogen contained within organisms.

COD

Chemical Oxygen Demand (COD) is a measure of the total oxygen required to complete the chemical and biological demands of a sample.

Fish Tissue Analysis

Fish tissue is analyzed to examine potential exposure of humans to toxicants as well as the health of the aquatic food chain. In aquatic systems toxic contaminants can build up (or bioaccumulate) within animals at the top of the food chain. Contaminants (especially organic pollutants) are retained within the fat tissue of an organism, therefore in fish samples the lipid content is often measured.

Lake Code Designation

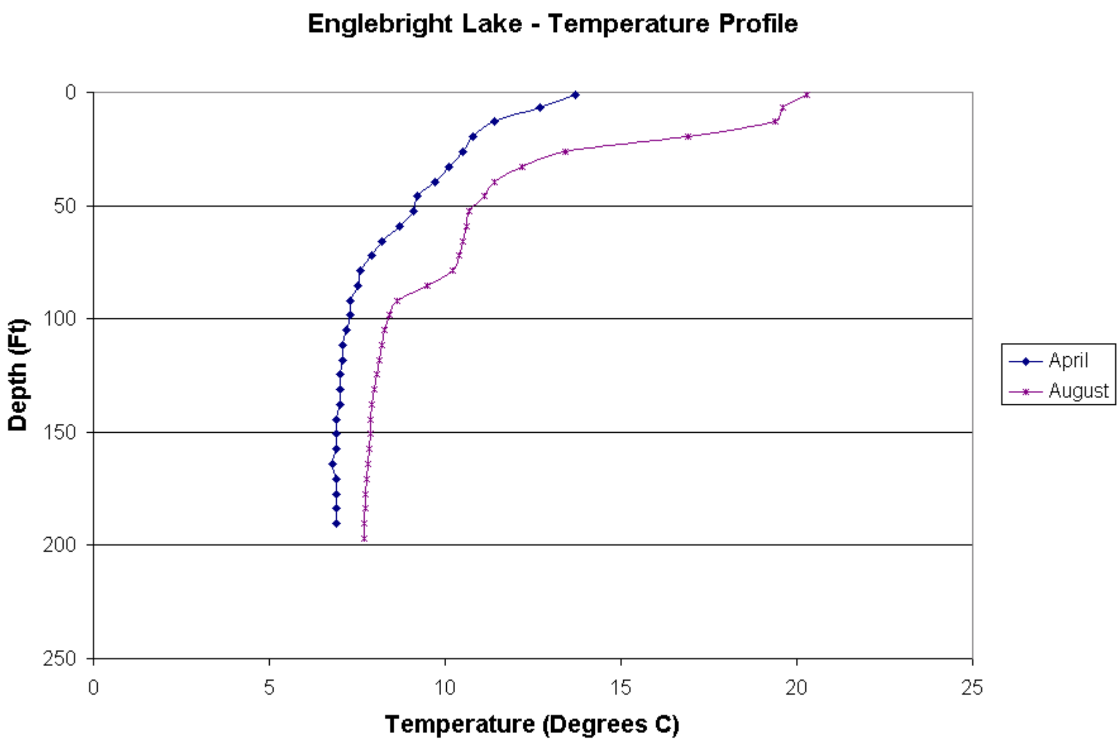
Laboratory Reports are provided in the previous sections.

Sample ID is "XX-YY-ZZ" where

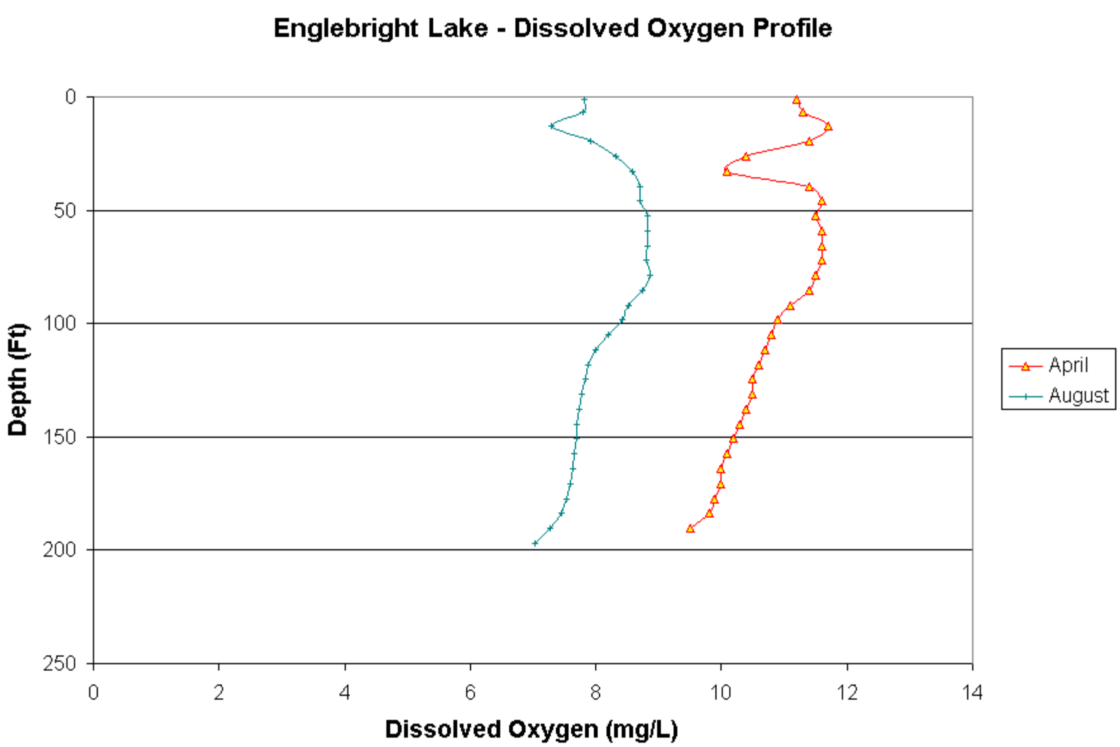
XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summar	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

Example: BB-SU-S is for a water sample taken from Black Butte in the Summer on the Lake's Surface.

Appendix B: Profile Data and Charts (Secchi Disc, Temperature, DO, and pH)

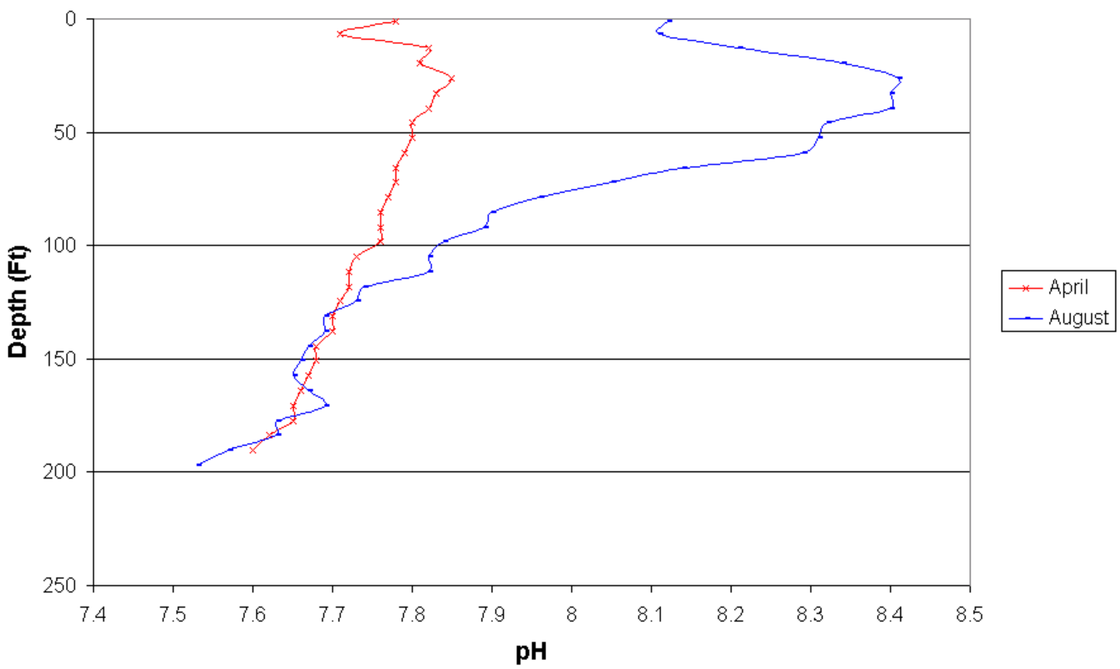


Englebright Lake - Temperature Profile
Depth (Ft)
0
50
100
150
200
250
0
5
10
15
20
25
Temperature (Degrees C)
April
August



Englebright Lake - Dissolved Oxygen Profile
Depth (Ft)
0
50
100
150
200
250
0
2
4
6
8
10
12
14
Dissolved Oxygen (mg/L)
April
August

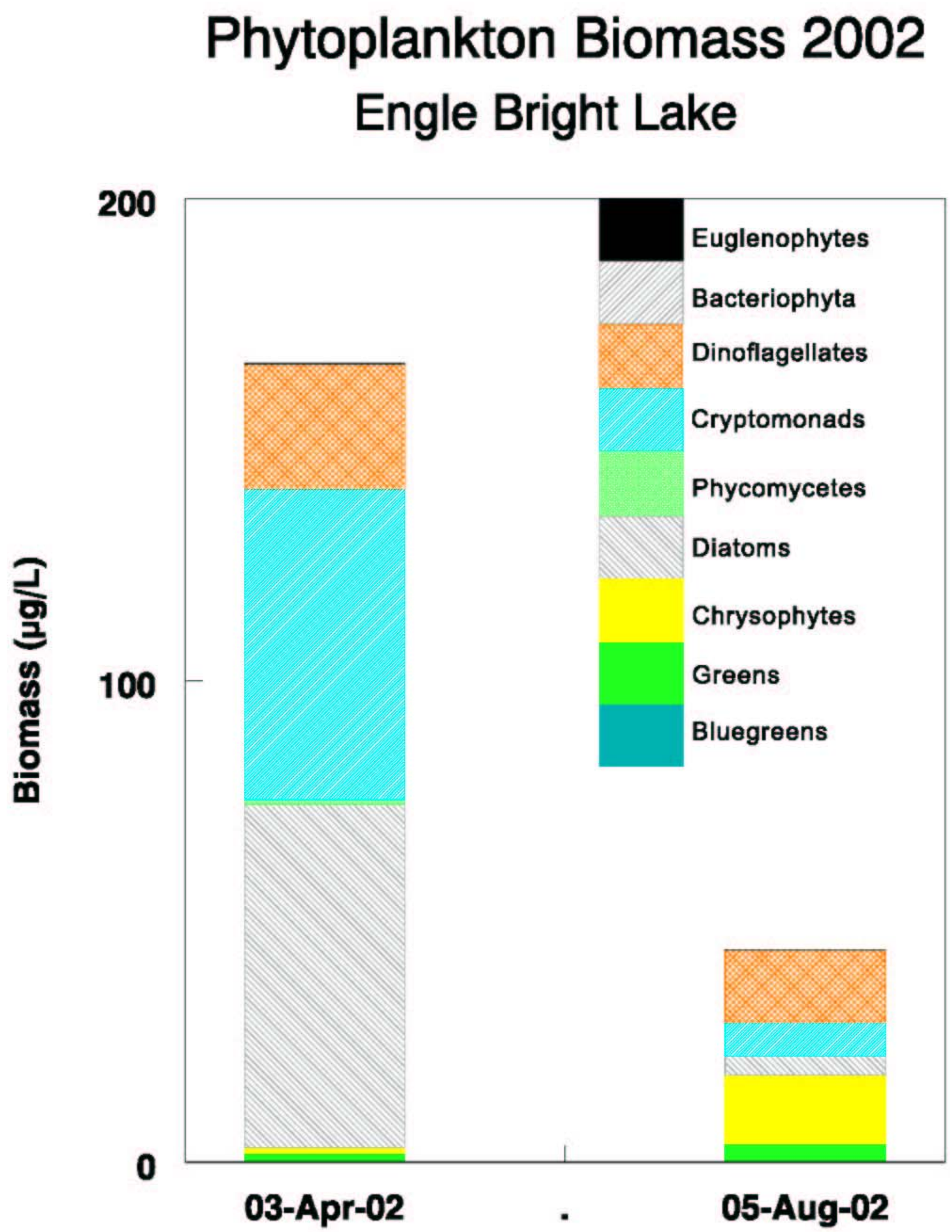
Englebright Lake - pH Profile



ENGLEBRIGHT					
Sample Location: Behind dam				**Date:** 4/03/02	
Observers: Tim McLaughlin				**Time:** 10:45 am	
Lake Elevation:					
Weather Conditions:					
Wind Speed: 0		**Precipitation:** 0		**Temp (F):** 75	
SECCHI Depth: 5 feet and 6 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
58.3	190.3	6.90	58	9.50	7.60
56	183.7	6.90	47	9.80	7.62
54	177.2	6.90	47	9.90	7.65
52	170.6	6.90	47	10.00	7.65
50	164.1	6.80	47	10.00	7.66
48	157.5	6.90	47	10.10	7.67
46	150.9	6.90	47	10.20	7.68
44	144.4	6.90	47	10.30	7.68
42	137.6	7.00	47	10.40	7.70
40	131.2	7.00	46	10.50	7.70
38	124.7	7.00	46	10.50	7.71
36	118.1	7.10	46	10.60	7.72
34	111.5	7.10	45	10.70	7.72
32	105.0	7.20	45	10.80	7.73
30	98.4	7.30	43	10.90	7.76
28	91.9	7.30	44	11.10	7.76
26	85.3	7.50	43	11.40	7.76
24	78.7	7.60	43	11.50	7.77
22	72.2	7.90	43	11.60	7.78
20	65.6	8.20	41	11.60	7.78
18	59.1	8.70	43	11.60	7.79
16	52.5	9.10	43	11.50	7.80
14	45.9	9.20	43	11.60	7.80
12	39.4	9.70	43	11.40	7.82
10	32.8	10.10	43	10.10	7.83
8	26.2	10.50	43	10.40	7.85
6	19.7	10.80	43	11.40	7.81
4	13.1	11.40	44	11.70	7.82
2	6.6	12.70	43	11.30	7.71
0.03	1.0	13.70	44	11.19	7.78
NORTH FORK YUBA (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
46.9	7.52		-	-	-
SOUTH FORK YUBA (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
57.3	7.68		-	-	-
VISUAL OBSERVATIONS: Water very cloudy.					

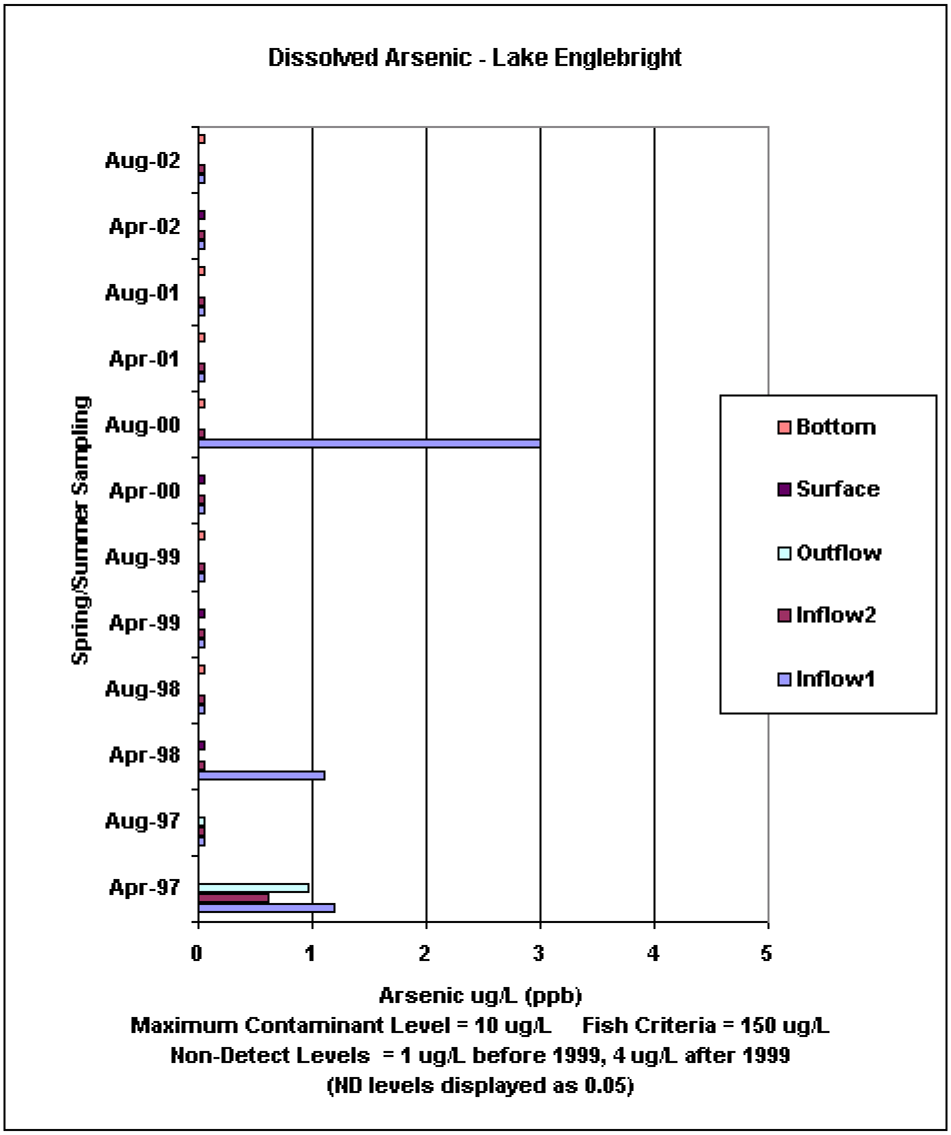
ENGLEBRIGHT					
Sample Location: Behind dam				**Date:** 8/05/02	
Observers: Tim McLaughlin				**Time:** 10:35 am	
Lake Elevation: 518.95					
Weather Conditions:					
Wind Speed: 5		**Precipitation:** 0		**Temp (F):** 80	
SECCHI Depth: 19 feet and 4 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
59.9	196.9	7.7	83	7.03	7.53
58	190.3	7.70	82	7.27	7.57
56	183.7	7.72	81	7.46	7.63
54	177.2	7.75	80	7.54	7.63
52	170.6	7.78	80	7.60	7.69
50	164.1	7.80	80	7.64	7.67
48	157.5	7.84	80	7.65	7.65
46	150.9	7.86	80	7.69	7.66
44	144.4	7.88	80	7.70	7.67
42	137.6	7.91	80	7.73	7.69
40	131.2	7.99	79	7.78	7.69
38	124.7	8.05	79	7.83	7.73
36	118.1	8.12	79	7.88	7.74
34	111.5	8.21	79	8.00	7.82
32	105.0	8.26	79	8.19	7.82
30	98.4	8.40	79	8.43	7.84
28	91.9	8.62	77	8.53	7.89
26	85.3	9.49	77	8.74	7.90
24	78.7	10.20	77	8.86	7.96
22	72.2	10.40	76	8.81	8.05
20	65.6	10.50	76	8.82	8.14
18	59.1	10.60	76	8.83	8.29
16	52.5	10.70	76	8.83	8.31
14	45.9	11.10	76	8.70	8.32
12	39.4	11.40	76	8.70	8.40
10	32.8	12.20	76	8.58	8.40
8	26.2	13.40	77	8.31	8.41
6	19.7	16.90	78	7.92	8.34
4	13.1	19.40	80	7.29	8.21
2	6.6	19.60	80	7.79	8.11
0.03	1.0	20.30	80	7.82	8.12
NORTH FORK YUBA (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
48.8	8.17		-	-	-
SOUTH FORK YUBA (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
69.8	8.04		-	-	-
VISUAL OBSERVATIONS: Water clear.					

Appendix C: Phytoplankton Data and Charts

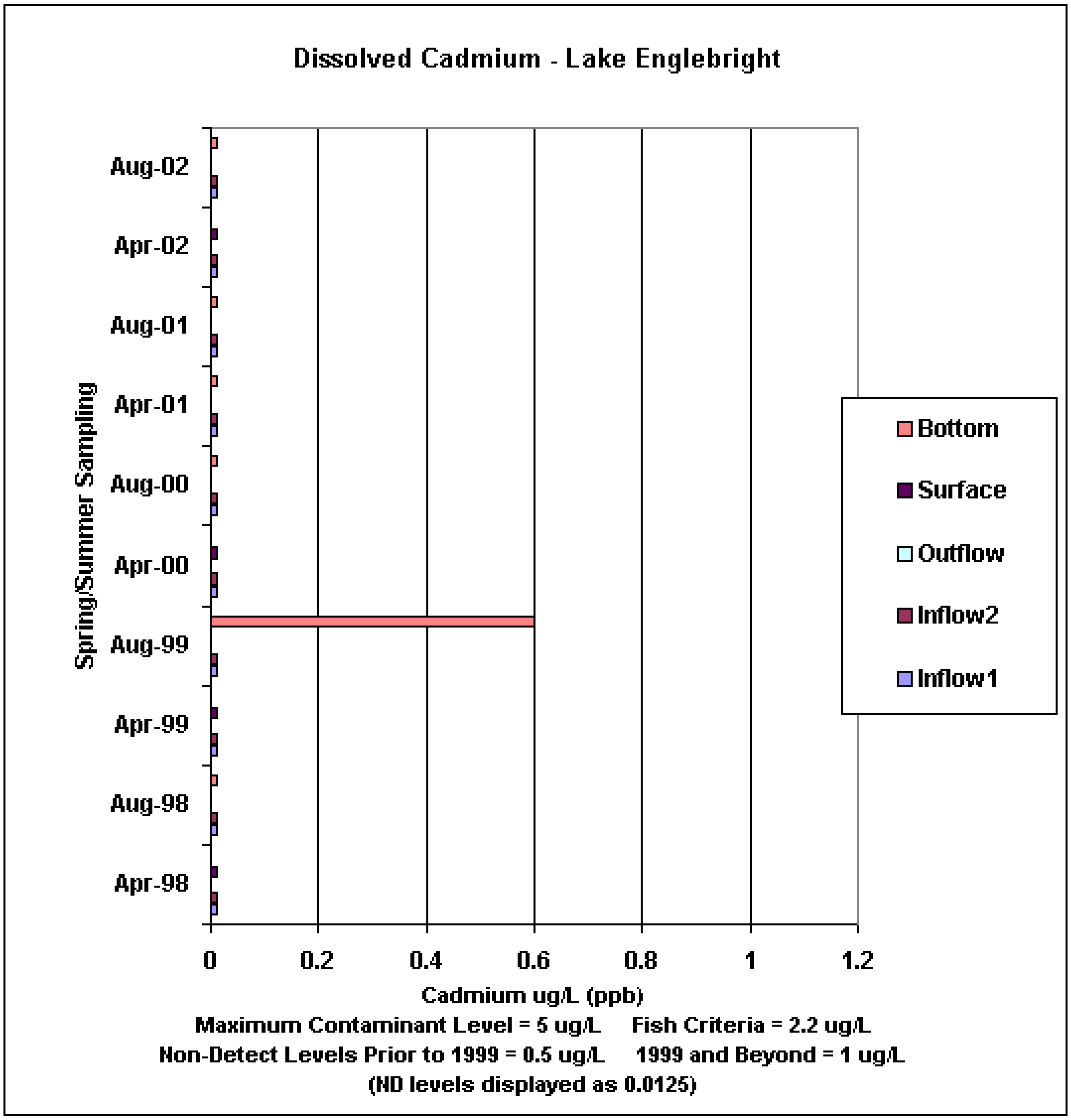


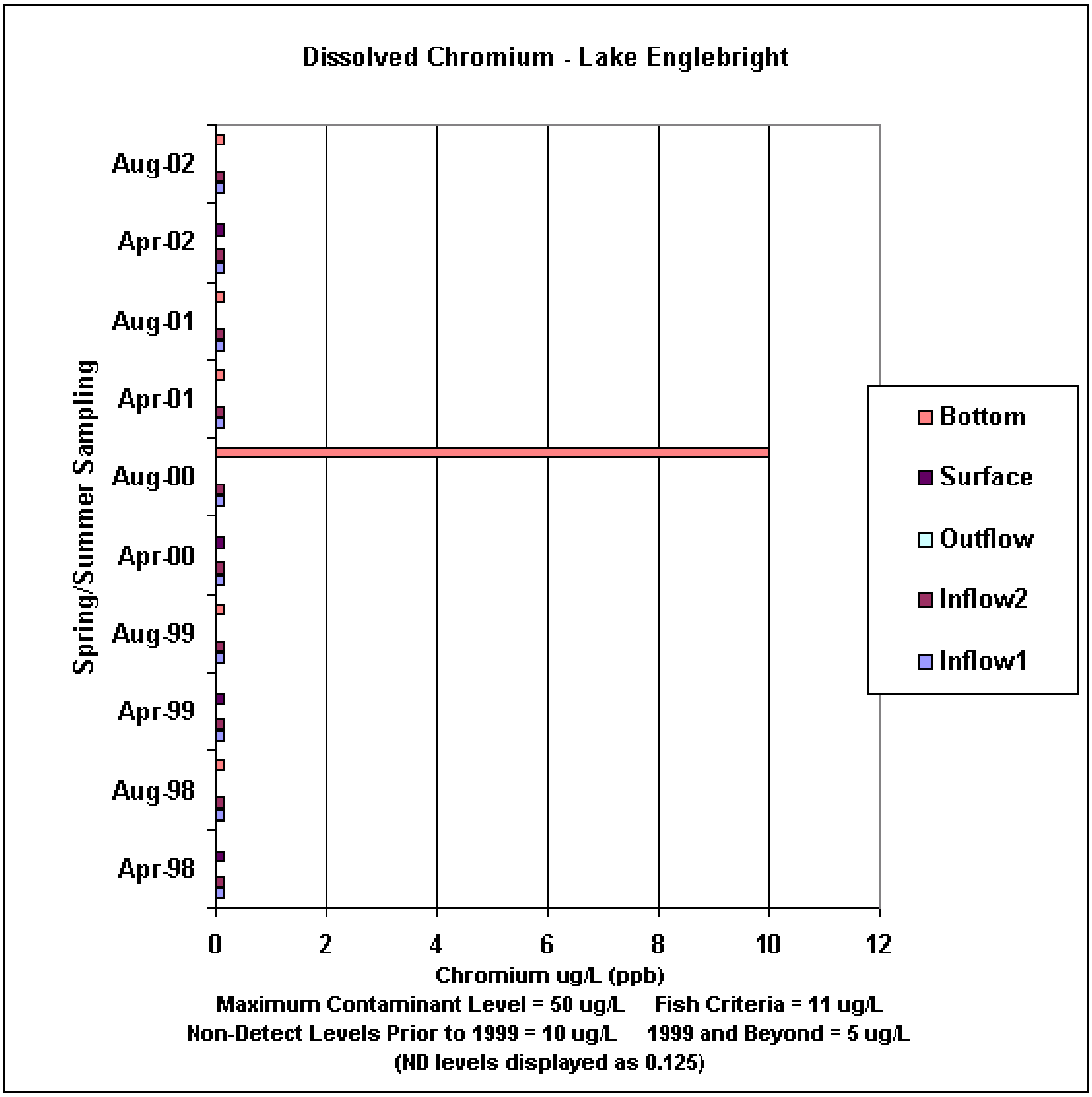
Phytoplankton Biomass 2002
Engle Bright Lake
200
100
0
Biomass (µg/L)
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
03-Apr-02
.
05-Aug-02

Appendix D: Metals Data and Charts

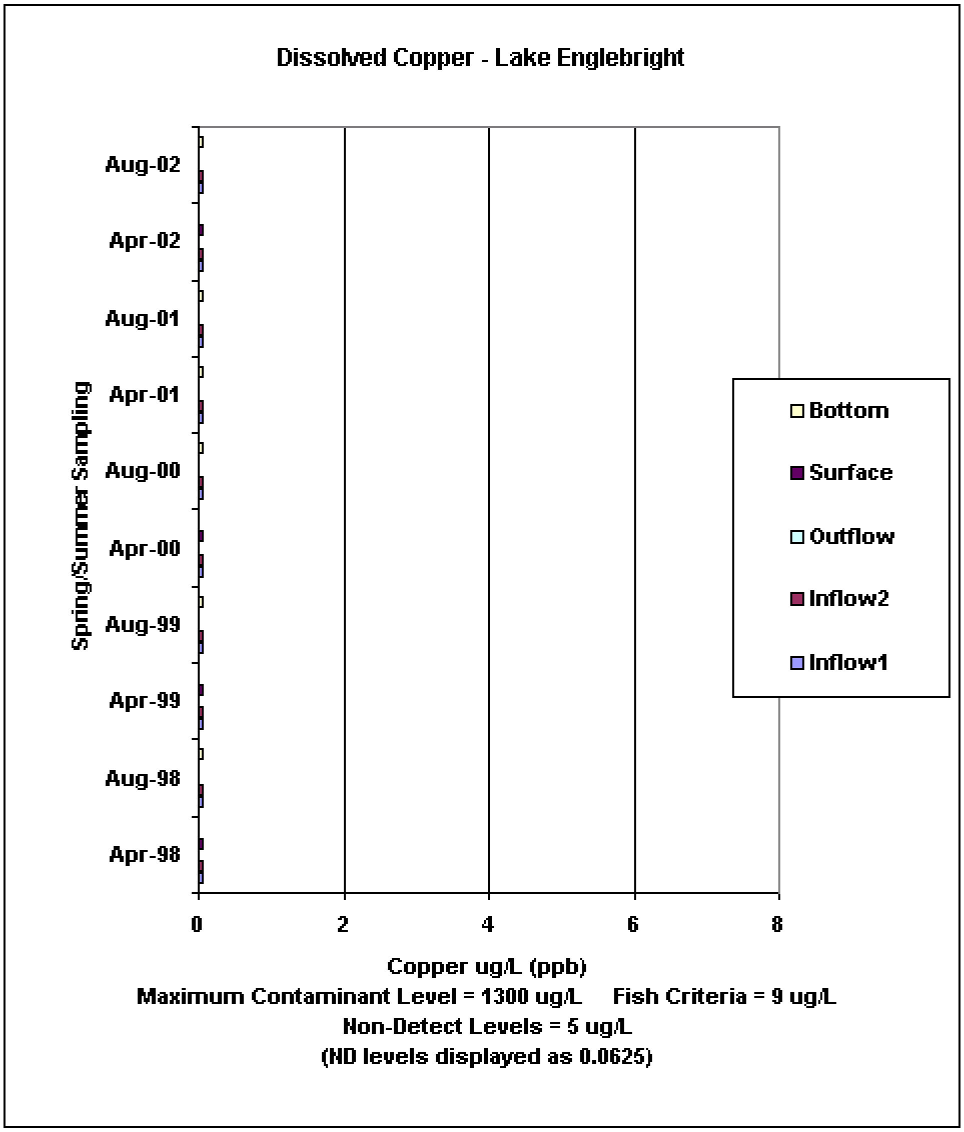


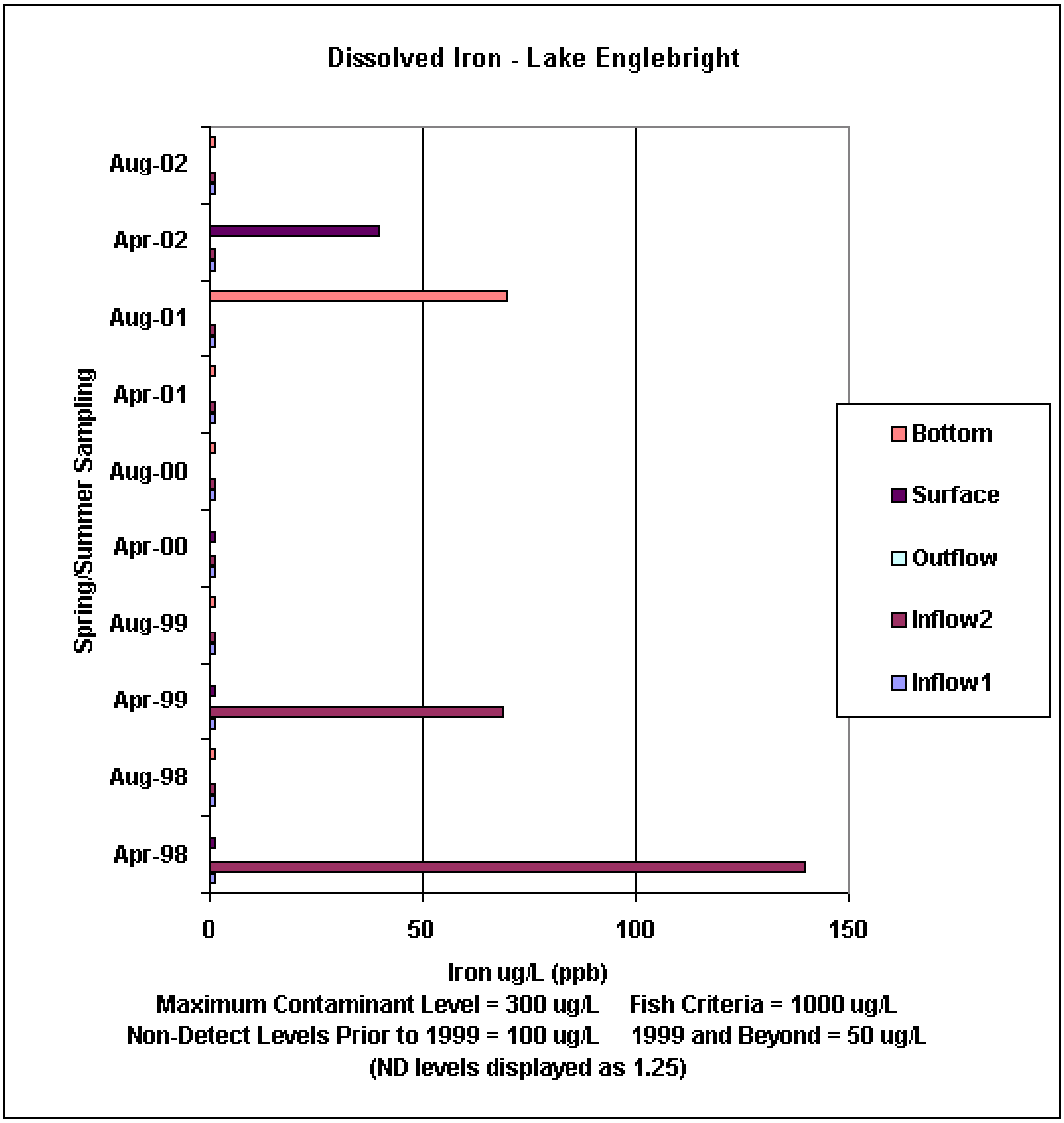
Dissolved Arsenic - Lake Englebright
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
0
1
2
3
4
5
Bottom
Surface
Outflow
Inflow2
Inflow1
Arsenic ug/L (ppb)
Maximum Contaminant Level = 10 ug/L   Fish Criteria = 150 ug/L
Non-Detect Levels = 1 ug/L before 1999, 4 ug/L after 1999
(ND levels displayed as 0.05)

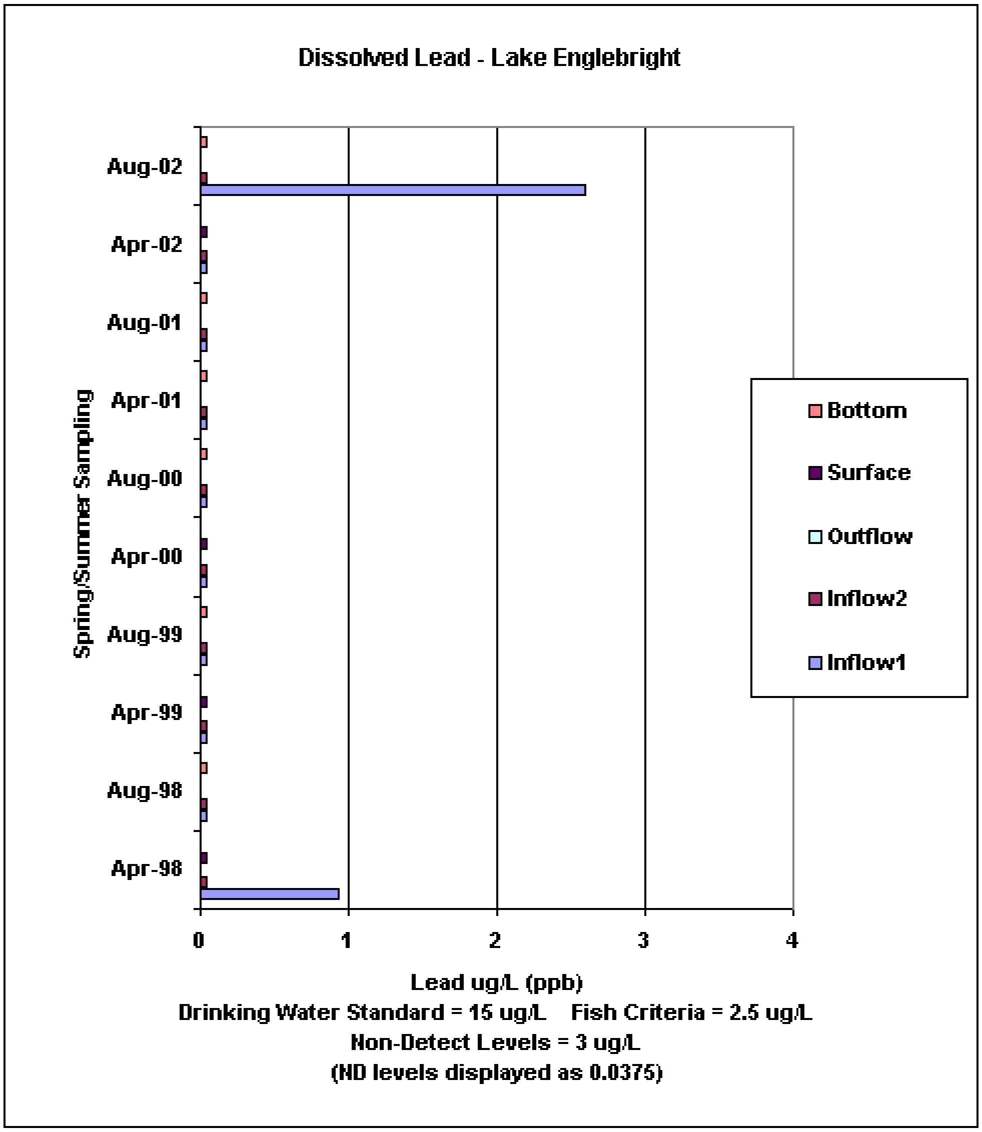

Dissolved Cadmium - Lake Englebright
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.2
0.4
0.6
0.8
1
1.2
Cadmium ug/L (ppb)
Maximum Contaminant Level = 5 ug/L Fish Criteria = 2.2 ug/L
Non-Detect Levels Prior to 1999 = 0.5 ug/L 1999 and Beyond = 1 ug/L
(ND levels displayed as 0.0125)
Bottom
Surface
Outflow
Inflow2
Inflow1

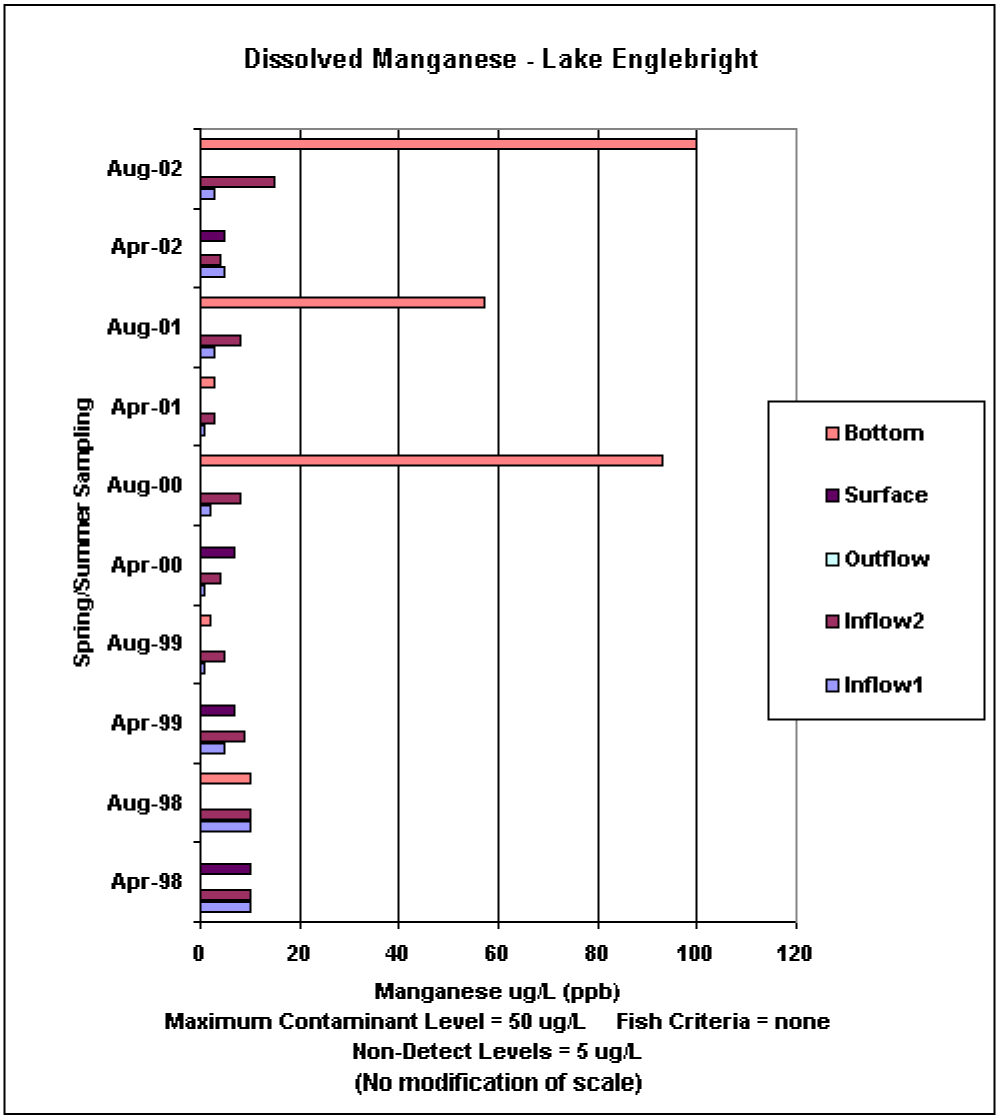


Dissolved Chromium - Lake Englebright
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
2
4
6
8
10
12
Bottom
Surface
Outflow
Inflow2
Inflow1
Chromium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L   Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L   1999 and Beyond = 5 ug/L
(ND levels displayed as 0.125)

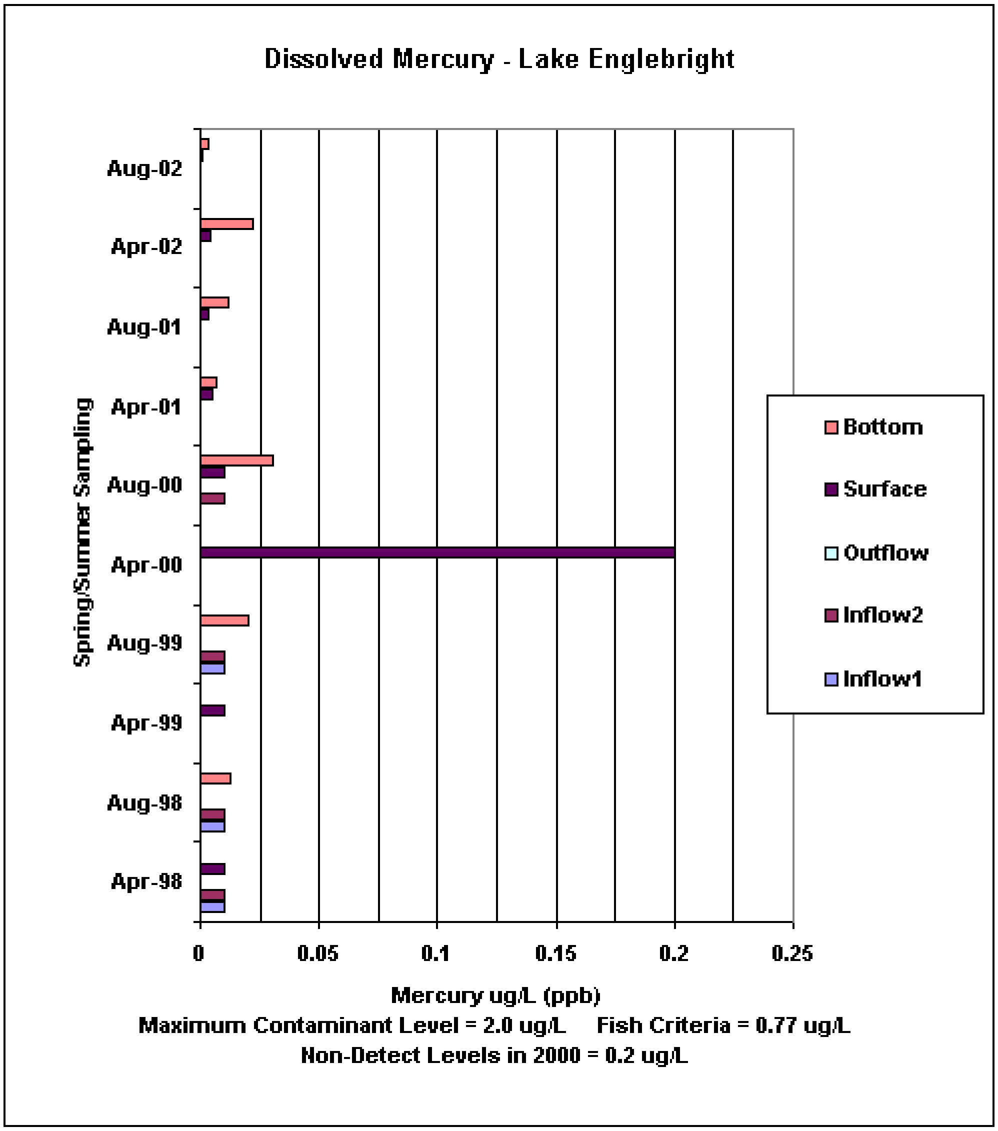

Dissolved Copper - Lake Englebright
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
Bottom
Surface
Outflow
Inflow2
Inflow1
Copper ug/L (ppb)
Maximum Contaminant Level = 1300 ug/L Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L
(ND levels displayed as 0.0625)


Dissolved Iron - Lake Englebright
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
50
100
150
Bottom
Surface
Outflow
Inflow2
Inflow1
Iron ug/L (ppb)
Maximum Contaminant Level = 300 ug/L Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L 1999 and Beyond = 50 ug/L
(ND levels displayed as 1.25)

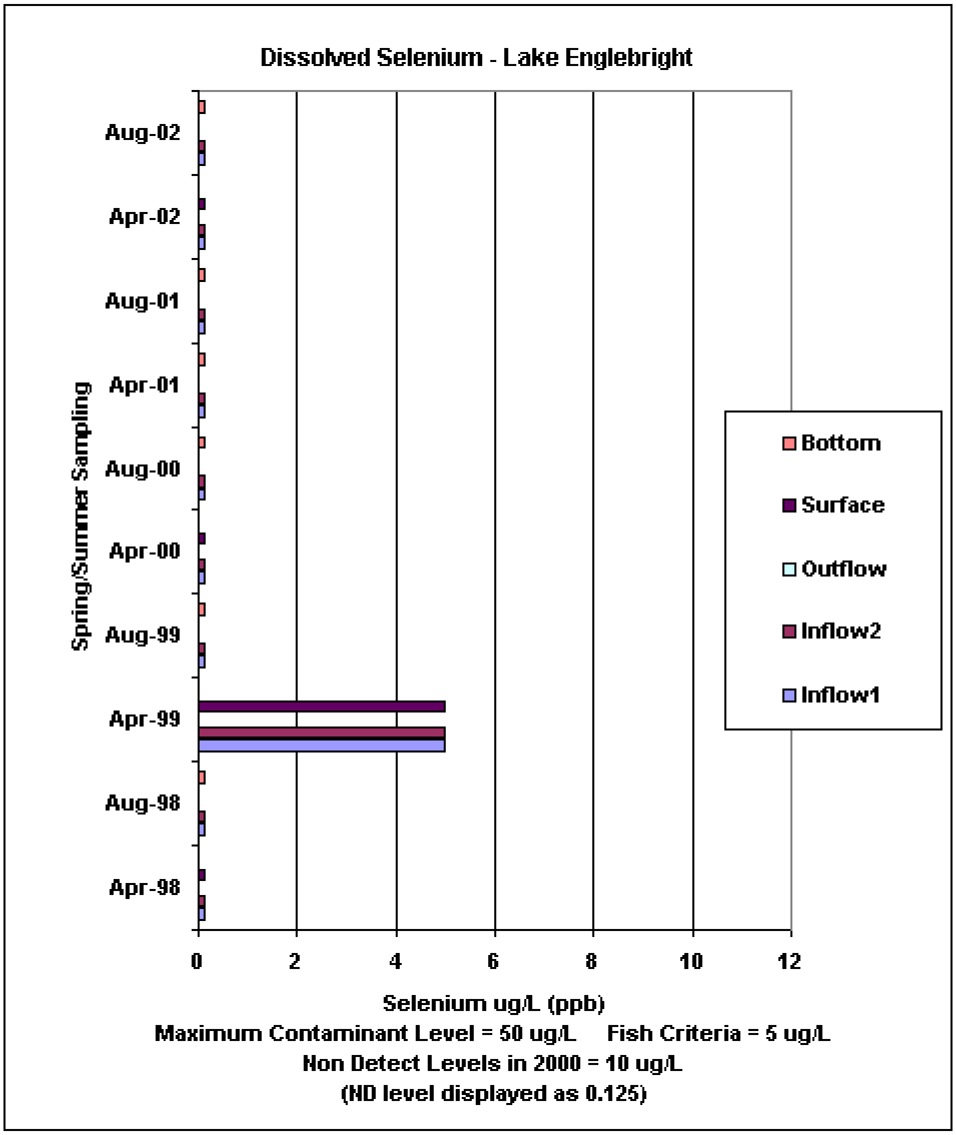

Dissolved Lead - Lake Englebright
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
Bottom
Surface
Outflow
Inflow2
Inflow1
Lead ug/L (ppb)
Drinking Water Standard = 15 ug/L Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L
(ND levels displayed as 0.0375)



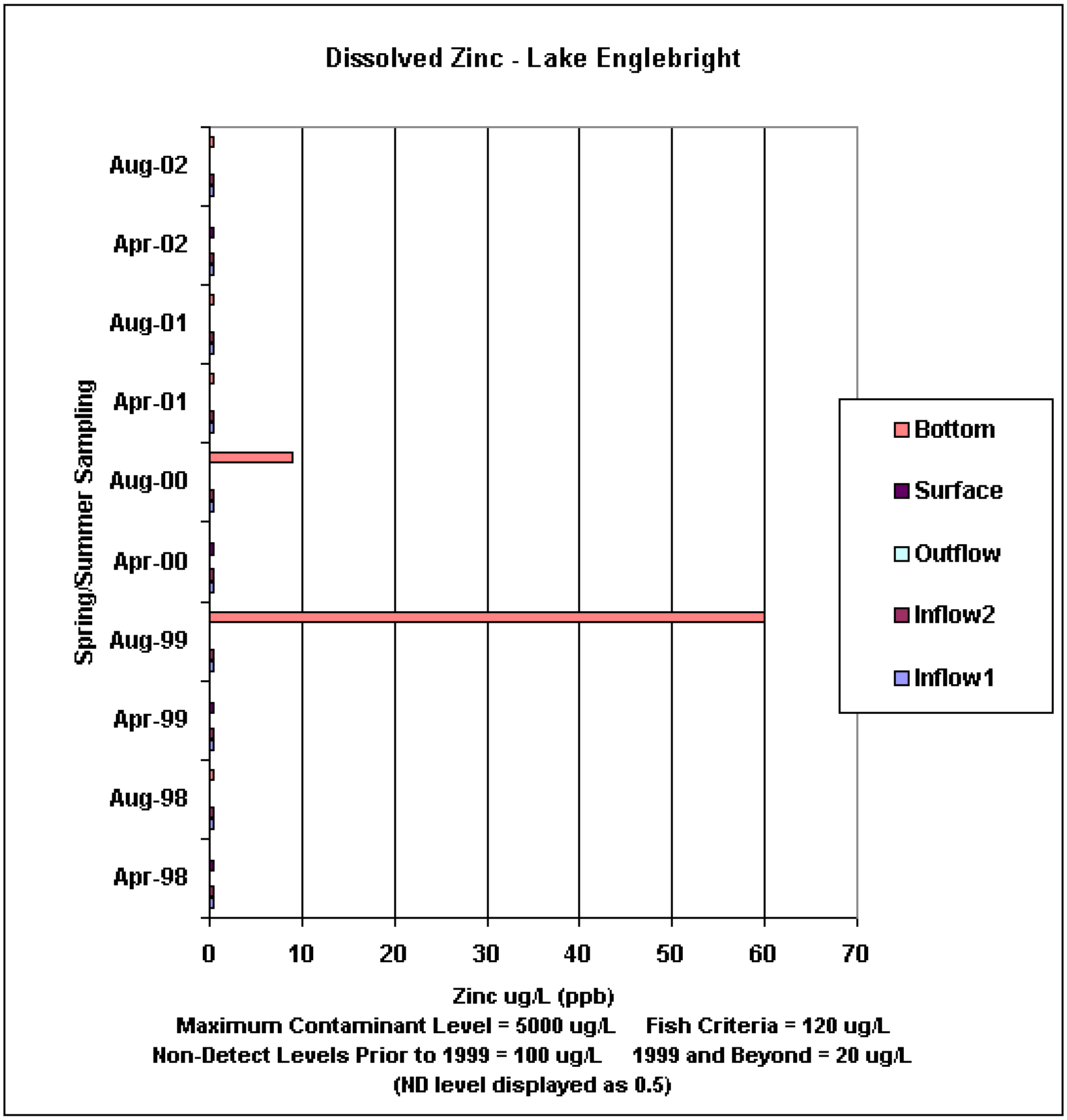
Dissolved Manganese - Lake Englebright
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
20
40
60
80
100
120
Bottom
Surface
Outflow
Inflow2
Inflow1
Manganese ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = none
Non-Detect Levels = 5 ug/L
(No modification of scale)



Dissolved Mercury - Lake Englebright
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Bottom
Surface
Outflow
Inflow2
Inflow1
0
0.05
0.1
0.15
0.2
0.25
Mercury ug/L (ppb)
Maximum Contaminant Level = 2.0 ug/L Fish Criteria = 0.77 ug/L
Non-Detect Levels in 2000 = 0.2 ug/L



Dissolved Selenium - Lake Englebright
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
2
4
6
8
10
12
Bottom
Surface
Outflow
Inflow2
Inflow1
Selenium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = 5 ug/L
Non Detect Levels in 2000 = 10 ug/L
(ND level displayed as 0.125)


Dissolved Zinc - Lake Englebright
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
10
20
30
40
50
60
70
Bottom
Surface
Outflow
Inflow2
Inflow1
Zinc ug/L (ppb)
Maximum Contaminant Level = 5000 ug/L   Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L   1999 and Beyond = 20 ug/L
(ND level displayed as 0.5)

Appendix E: Inorganic Sample Data

Inorganic Results (mg/L) For surface lake waters (spring)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity		60	40	50	60	30	40	70	80	20		100
Ammonia		<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Chloride		21	2	21	4	4	3	<1	6	5		4
Nitrate		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1		<0.1
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Sulfate		5.3	2.6	4.2	8.9	2	1	8.2	9	2.1		4.7
Kjeldahl N		0.6	0.1	0.4	0.2	<0.1	0.3	0.2	0.2	0.2		<0.1
COD					<50							
Tot Solids		120	70	100	110	60	78	100	120	21		150

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	100	70	40	50	20	30	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	13	25	3	21	<1	<1	4	<1	6	4	3	2
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	
Sulfate	18	2.1	2.3	3	2.8	1.9	0.8	8.8	11	1.6	11	3.5
Kjeldahl N	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1
COD	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	170	130	59	110	60	60	90	110	150	30	130	90

Inorganic Results (mg/L) For surface lake waters (summer)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	140	70	40	50	50	40	70	90	80	10	80	110
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
Chloride	16	26	4	19	6	5	5	5	9	3	5	8
Nitrate	<0.1	1.5	<0.1	1.3	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1
Total P	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	16	4.1	3.6	3.5	5.9	2	0.7	7.4	14	1.6	6.4	4.4
Kjeldahl N	<0.1	2.7	<0.1	0.4	0.4	0.3	<0.1	0.2	<0.1	<0.1	0.2	0.6
COD	<50	60	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	200	190	50	120	98	80	80	120	120	52	100	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	90	40		60	40	80	100	130	20	110	180
Ammonia												
Chloride	16	490	5		10	8	3	5	14	4	5	22
Nitrate												
Total P												
Ortho P												
Sulfate	16	4.5	3		9.8	3.2	<0.5	6	14	2.7	5.4	8.7
Kjeldahl N												
COD												
Tot Solids	200	1300	50		140	100	100	150	200	50	140	280

Appendix F: MTBE Table

2002 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2002 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	2		2		<2		<2		
Eastman	5				<2				
Englebright	3		3		10		10	10	
Hensley	3		3		3		3		
Isabella	<2	<2	<2	<2	<2	<2	<2	<2	
Kaweah	2		2	<2	8		6	6	
Martis Cr.	<2				<2				
Mendocino	<2				<2				
New Hogan	<2				3				
Pine Flat	<2		<2		2		2		
Sonoma		3	<2		<2		2		
Success	4		4	4	11	12	11	11	

Notes:

1. Non-Detect is indicated by "<2" since the Reporting Limit is 2 ppb or 0.002 ppm.

2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.

3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.

4. For 2002, the number of MTBE water sampling at each lake is based on last year's lab results.

5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was historically non-detectable. The 2002 results of non-detectable levels were similar except Lake Eastman and New Hogan now reported low, detectable levels of MTBE.

6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because of historically low detectable levels of MTBE.

7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because of historically higher MTBE being found. The 2002 results were similar except Isabella now reported non-detectible levels.

8. In 2001, very high MTBE levels were reported at Lake Isabella during the Spring (18 ug/L near the marina) . During Spring 2000, Lake Isabella reported 21 ug/L. The 2002 results indicate that the previous MTBE problem near the marina was not visible during the Spring 2002 sampling event, and may have been rectified.

G. Fish tissue analysis table

2002 Fish Tissue Results

The following table provides an overview of the lab results for the 2002 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conductng the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The California OEHHA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Mercury Total ppm	FDA Criteria
Black Butte	Sm M Bass	Composite (3)	6/12/02	0.24	0.26	1 ppm
Eastman	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Englebright	Note 5	N/A	N/A	N/A	N/A	
Hensley	Black Bass	Composite (3)	4/23/02	<0.10	0.72	1 ppm
Isabella	Black Bass	Composite (3)	6/4/02	0.20	0.21	1 ppm
Kaweah	Sm M Bass	Composite (3)	7/14/02	0.11	0.53	1 ppm
Martis Cr	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Mendocino	Note 6	N/A	N/A	N/A	N/A	
New Hogan	Lg M Bass	Single (1)	6/3/02	<0.10	0.34	1 ppm
Pine Flat	Note 4	--------------------	-----------	----------	-----------	< Mon 01
Sonoma	Note 6	N/A	N/A	N/A	N/A	
Success	Black Bass	Composite (3)	4/15/02	<0.10	0.18	1 ppm

Notes:

9. Non-Detect is indicated by "<0.02". The lab Detection Limit for mercury is 0.02 ppm.
10. Total Mercury was reported in mg/g or ppm.
11. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.
12. The fish tissue program was terminated at Eastman and Martis Creek in 2001 and in Pine Flat in 2002 due to low total mercury results. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout). For Pine Flat total mercury was 0.21 ppm in 2000 (composite of three Sacramento Sucker fish) and 0.23 in 2001 (composite of three spotted bass).
13. Due to seasonal conditions, a fish could not be successfully collected at Lake Englebright. Another attempt will be accomplished for the 2003 report.
14. Fish were not collected at Mendocino or Sonoma due to communication difficulties.

The above 2002 total mercury results indicate only Hensley is higher than average. However, in 2001, the total mercury results were only 0.30 ppm for Hensley (small mouth bass). The 2003 fish tissue program should provide additional data. EPA fact sheet on fish advisories (EPA-823-F-99-016) indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.

Annual Water Quality Report

HENSLEY LAKE

Water Year 2002

Written by
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Water Quality Engineer
U. S. Army Corps of Engineers
Sacramento District
January 2003

TABLE OF CONTENTS

Hensley Lake

I. Purpose

This report is part of an environmental monitoring program that began at Hensley Lake in August 1976. The monitoring program determines the level of water quality in the lake for both recreation and environmental health and satisfies the requirement for an annual water quality report in Department of Army Engineering Regulation 1110-2-8154, "Water Quality and Environmental Management for Corps Civil Works Projects".

II. Brief Description of Hensley Lake

Hensley Lake is located in central California, 17 miles northeast of Madera. The lake is nestled in the Sierra Nevada foothills and is surrounded by grasslands and blue oaks. At maximum capacity, the lake has 1,500 surface acres and holds 90,000 acre-feet of water. The lake was created by the construction of Hidden Dam on the Fresno River. The dam is 163 feet high and 5,730 feet in length. Since being built by the US Army Corps of Engineers for flood control and irrigation, the lake has become a popular destination for recreation. Summers are warm and the winters mild, allowing for year-round recreation.

Water quality monitoring by the United States Army Corps of Engineers (USACE) began at Hensley Lake in August 1976. Generally there are two sample events a year, spring (April) and late summer (August). Since the start of the monitoring program, a water quality report is produced yearly to list results and addresses any concerns of the previous water year.

Generally Hensley Lake has a depth of < 90 ft during the sampling events, and is considered a eutrophic (nutrient rich) lake when characterized by its clarity. One of the common characteristics of a eutrophic lake such as Hensley Lake is that during warm late summer months the lower depths are low in dissolved oxygen (DO). Additionally Hensley Lake is warm (>20ºC) in the late summer. Due to both the low DO concentrations and high temperatures, only warmwater fish species could reliably survive in the lake. Warmwater fish species include bass, carp, perch, bluegill, crappie, and catfish. Another characteristic of eutrophic (nutrient rich) lakes is their low water clarity due to algal blooms. In addition, shallow water sediments can be suspended by wind action which is another detractor to clarity. Water clarity is often measured in terms of Secchi Disc depth or SD (Appendix A). Historically the water clarity in Hensley Lake has been fairly low with ~26 % of the samples not meeting the recreational goal of 4 feet or greater (Figure 1). In 2001 the Spring SD measure was 11.33 feet, but the late summer sample was below the goal of 4 feet (SD = 3.33).

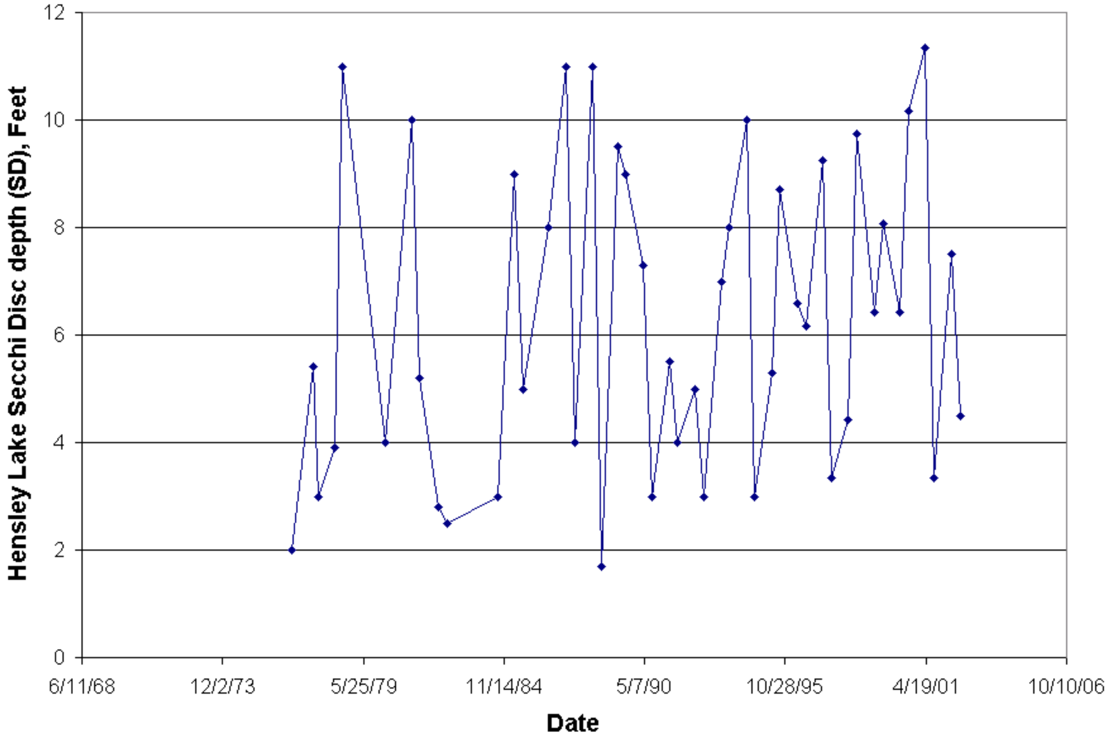

Figure 1. Historical Secchi Depth Values at Hensley Lake(2002 values included).

The 2001 Water Quality Report listed no significant contaminants of concern in Hensley Lake. One thing to note is that historically the concentration of mercury found in fish tissue was at the USEPA's action level concentration (0.3 ppm Hg) to continue monitoring.

III. Sample Summaries for this year.

Introduction

The following general summaries are split into their respective sample types. Each type of sample summary includes a discussion of both the spring (April) and late summer

(August) samples to better examine trends within the current year. The types of parameters monitored this year include: Secchi Disc depths, water column profiles (temperature, DO and pH), phytoplankton characterization, metals concentrations, MTBE concentrations, Inorganic characterization (alkalinity, phosphorous, nitrogen, etc..), and fish mercury concentrations. For a more detailed explanation of the importance for each type of sample, please see Appendix A.

SECCHI DEPTH

The Secchi Disc depths found during spring and late summer sampling were similar to previous events. Traditionally the lake varies in its clarity. More often the clarity is better in the spring than in the late summer. In spring the water clarity was higher and had a SD of 7.5 feet. The late summer SD of 4.5 feet was above the recreational goal of 4 feet and an improvement from last year (Summer 2001 SD = 3.33) (Appendix B).

TEMPERATURE VALUES

The temperature profiles for Hensley Lake are indicative of a seasonally well-mixed shallow lake. The lake is well stratified in the spring, but the layers disappear by the warm temperatures of late summer. The difference in the depth of the lake between the spring and late summer sampling events was minimal (spring depth = 59.1 feet, late summer depth= 52.5 feet), but the average temperatures were very different (spring average temp. = 10.95 ºC, late summer average temp.= 24.49 ºC). Hensley Lake does not have a deep water region to buffer it from the warm summer air temperatures. Due to the warmth of the water, Hensley Lake probably wouldn't be able to support coldwater fish species for long term survival. For detailed results obtained during the sampling events, please see Appendix B.

DISSOLVED OXYGEN

The dissolved oxygen (DO) concentration differs greatly from spring to late summer. In the spring DO concentrations are super saturated (10.50 mg/l DO) near the surface and lower at the bottom (6.76 mg/L) of the lake. DO concentrations near the surface are above saturation (9.14 mg/l at 19.7 ºC) due to phytoplankton photosynthesis. DO concentrations in the late summer are much lower and have a steady gradient from near the surface (DO = 5.05 mg/l) to the bottom of the lake (DO =1.29 mg/l). The low DO values at the bottom of the lake are associated the decomposition of waste materials at accelerated rates due to the warm temperatures. Fish species that require greater than 5 mg/l DO at cooler water temperatures (< 20ºC) would be unlikely to survive year round in Hensley Lake. For detailed results obtained during the sampling events, please see Appendix B.

pH.

In the spring sample event, pH values in the lake were slightly basic (pH = ~7.7) throughout the water column. The pH values in the late summer profile varied widely. The pH was more basic towards the surface and middle waters (max pH = 9.20) and less basic [because 7 is neutral and rainwater is 6.5, I wonder if we can say that it is basic as opposed to just more basic] at the bottom (pH = 7.86). Lower pH values at the bottom of the lake increase the likelihood that higher soluble metal concentrations will be found in lake bottom samples. For detailed results obtained during the sampling events, please see Appendix B.

PHYTOPLANKTON

In the spring sample, the algal biomass within the lake was high (Biomass = 3070.7 μg/L) compared to spring 2001 (2001 Spring biomass = 420.24 μg/L). In spring 2001 dinoflagellates were the most dominant species, but in spring 2002 diatoms dominated. In late summer the same trend occurred and the phytoplankton population was much lower in summer 2001 (2001 Summer Biomass = 2357.8 ug/L) than summer 2002 (Biomass = 9357.3 ug/L). Blue green algae was the most dominant species during the 2002 late summer sampling events, but diatoms dominated in summer 2001. While most phytoplankton species must obtain nitrogen (a required nutrient for growth) from aqueous forms in the lake, bluegreen algae have the ability to use the atmospheric form or nitrogen gas (nitrogen fixation). In lakes that are limited in nitrogen availability, the ability to fix nitrogen is a distinct advantage. Bluegreen algae are often thought of as a nuisance due to the inability of it to be used in the aquatic food chain it has a deleterious impact on water clarity. For detailed results obtained during the 2002 sampling events, please see Appendix C.

METALS

Most of the dissolved heavy metal samples did not exceed the maximum contaminant level (MCL) or the freshwater fishery criteria during either the spring or summer except for dissolved iron and manganese. Although dissolved mercury samples did not exceed any criteria, the concentration in one sample while only in the parts-per-billion range was an uptick from last year, but less than previous year's values. It should be noted that when testing for mercury at such low limits, variations in field technique can result in relatively "large" values.

While dissolved iron concentrations had exceeded the Secondary Maximum Contaminant Level (MCL) (Iron MCL = 300 ppb) in the past, the late summer bottom iron concentration was extremely high (Iron on the bottom in summer 2002 = 1400 ppb). The summer bottom sample even exceeded the fish criteria limit (Fish Criteria Limit =1000 ppb).

In late summer 2002, water at the bottom of the lake had a manganese concentration of 220 ppb. This was the highest manganese concentration since monitoring began in 1998. The concentration was above the secondary MCL (manganese = 50 ppb). This criteria is termed "secondary" because it relates to water hardness not health.

The dissolved mercury concentration in late summer sample at the bottom of the lake did not exceeded the fish criteria limit of 0.77 ppb. The concentrations of dissolved mercury in bottom lake samples for spring and late summer sampling events were 0.0049 ppb and 0.065 ppb respectively. For detailed results obtained during the sampling events, please see Appendix D.

MTBE

Concentrations for MTBE around the lake were found to be 3 ppb during both spring and late summer sampling events. For detailed results obtained during the sampling events, please see Appendix F.

INORGANIC ANALYSIS

The spring sample analysis had several results worth discussion involving chloride, and nitrates. The chloride concentration in the spring sampling event was high (Spring lake chloride = 21 ppm, Spring inflow chloride =21 ppm) when compared to previous years (Spring 2001 lake chloride = 18 ppm, Spring 2001 inflow chloride =19 ppm) and was higher than most of the other lakes monitored by the USACE. The summer chloride concentration was also higher in the lake than last year (Summer lake chloride = 19 ppb, Summer 2001 lake chloride = 11 ppb).

Late summer 2002 sampling also indicated detectable levels of nitrate in the lake. While nitrate values were below detection in the spring (< 0.1 mg/L), a concentration of 1.3 mg/L was found in the lake during the late summer sampling event. Interestingly, Total Kjeldahl nitrogen (TKN) in the lake remained steady at 0.4 mg/L. For detailed results obtained during the 2002 sampling events, please see Appendix E.

FISH TISSUE ANALYSIS

Fish tissue analysis for total mercury was performed on a composite sample composed of tissue from three black bass collected in April 2002. The composite sample had a resulting total mercury concentration of 0.72 ppm. This is below the U.S. F.D.A. criteria for a fish advisory (1 ppm), but well above the concentrations found in the other lakes monitored. The 2002 composite sample had a higher mercury concentration than both the 2000 (0.30 ppm) and 2001 (0.70 ppm) fish composite samples. Due to two consecutive years of high mercury concentrations within samples, a more detailed fish analysis is suggested. For detailed results obtained during the sampling events, please see Appendix G.

IV. Conclusions.

Hensley Lake is a relatively shallow eutrophic lake that can support warmwater fish species. Coldwater fish that require temperatures below 20°C and dissolved oxygen concentrations greater than 5 mg/L would have difficulties surviving the summer conditions at Hensley Lake. Due to a lower pH and the anaerobic conditions ideal for bacterial growth near the bottom of the lake during the late summer, some heavy metals within lake sediments are being converted into soluble forms.

A contaminants of concern in Hensley Lake is dissolved iron . Iron results were higher than fish criteria levels at the bottom of Hensley Lake during the 2002 sample year. Manganese concentrations were above the secondary MCL for domestic use.

Fish tissue mercury concentrations were high for a second consecutive year (~0.7 ppm). While the concentration of mercury in the fish was below the U.S.F.D.A. 1 ppm action level, a more detailed examination of mercury in the lake is suggested.

V. References

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VI. Appendices

Appendix A: Glossary of Sample Types

Glossary of Sample Types

This glossary of sample types is intended to provide a general background and indicate the importance of each sample in determining water quality. These are meant to be brief and basic. If a further explanation is desired please refer to the list of references provided in this report.

Secchi Depth

One of the oldest and easiest methods to determine lake clarity is the Secchi depth (SD). The Secchi depth is determined by dropping a Secchi disc into a water body and determining the depth that it is last visible from the surface of the water. Secchi discs are generally white and 20 cm in diameter. Secchi depth values are most impacted by the light intensity at the time of sampling and the scattering of light by solid particulates within the water column. Algal growth (phytoplankton) and sediment re-suspension are often major constituents of solid particulates within the water column. Secchi depth values can be used to estimate the Trophic state or the nutrient levels within the lake. The more nutrients are available, the larger likelihood of algal blooms that limit water clarity. Due to recreational concerns for safety, the goal for Secchi depth values is four feet or greater.

Temperature Profiles and Data Points

The temperature profile of a lake provides information how a lake is operating and the potential for aquatic biota to live within the lake. The temperature profile is a direct indicator if a lake is stratified. Stratification in lakes is created generally by temperature affecting the density of water molecules. Stratification is usually indicated by a region of similar temperature nearer the surface of the water (epilimnion), then a region of temperature transition (metalimnion), to another layer of nearly constant temperature at the bottom of the lake (hypolimnion). Each layer in a stratified lake is important, but the existence of a hypolimnion can drastically impact how well a lake can handle warmer temperatures such as those found in northern California during the summer. The hypolimnion acts as a buffer against large temperature shifts. The nature of dam operation is that water is discharged near the bottom, releasing the hypolimnion, and eliminating stratification. This operation limits the ability of reservoirs to regulate their temperature during the summer months. Stratification isn’t always desirable. When a lake isn’t stratified and is instead well mixed, the required nutrients near the bottom of the lake become available to phytoplankton for growth. Temperatures within lakes also indicate which species of fish will survive within a lake. Coldwater species of fish require temperatures below 20 degrees C in order to spawn and survive. If a lake is often above 20 degrees C, then only warmwater fish species will survive.

Dissolved Oxygen (DO) Concentration Profiles

DO is required by organisms for respiration and for chemical reactions within lake waters. The recommended level for DO for most aquatic species survival is 5mg/L. In lakes, biota waste (detritus) falls to the bottom of the lake to be utilized by bacteria. The bacteria need oxygen and will deplete levels near the bottom of a lake, especially during warm temperature, high respiration conditions. For nutrient rich (eutrophic) lakes more organisms will grow, create wastes, and cause oxygen depleted regions at the lowest areas. Under these conditions only aquatic species that can survive low DO conditions in warm water near the surface will survive.

PH Profiles

The pH profiles of the lakes indicate the potential for certain chemical reactions to occur. In high pH (greater than pH = 7 or basic) aquatic systems, metal pollutants tend to form into insoluble compounds that fall onto the lake floor. In low pH (less than pH = 7 or acidic) systems or areas metal ions become soluble and available for uptake into aquatic organisms. Other compounds like ammonia that are introduced into a low pH aquatic environment will transform into soluble nitrate and be utilized by organisms.

Phytoplankton Analysis

Phytoplankton analysis indicates the health, nutrients, and biodiversity within a lake. Lakes that have few nutrients available (Oligotrophic) will generally have a much lower quantity of phytoplankton (high Secchi depth) but the number of phytoplankton species seen will be large. In a lake that is nutrient rich (eutrophic) there are generally large phytoplankton blooms (low Secchi depth), but they are made up of a couple of phytoplankton species. Certain species of phytoplankton are preferred food sources for zooplankton (small invertebrates). Generally species like diatoms and green algae can be consumed by the filter-feeding zooplankton, but species like bluegreen algae are low in nutrients and are difficult to consume. Some species like the dinoflagellates can grow horn like points to discourage potential predators. In nutrient rich waters where there is plenty of phosphorous, nitrogen can be limited for biological growth. While most species can't grow due to the lack of nitrogen, bluegreen algae (cyanobacteria) have the ability to utilize nitrogen from the atmosphere when required. This gives bluegreen algae the ability to dominate in many eutrophic lakes.

Soluble Metals Analysis

The soluble metals analysis indicates the exposure of humans and aquatic organisms to toxic metals. These metals often build up as they are consumed through the food chain. Water samples provide an indicator for additional problems. Soluble forms of metal ions are more prevalent in low pH (pH <7, or acidic) environments.

MTBE Analysis

MTBE (methyl tertiary-butyl ether) is a chemical additive to gasoline to improve combustion. Due to its high solubility, MTBE travels and blends into aquatic systems rapidly. While not found to be extremely hazardous at low levels, the offensive smell and taste is detectible by humans at extremely low concentrations. The effect of MTBE on humans and aquatic systems is still under investigation.

Inorganic Analysis

Alkalinity

Alkalinity is measured in terms of mg/L of calcium carbonate. It indicates a lakes ability to buffer incoming acidic pollution and situational changes.

Ammonia

Ammonia is a gas that is toxic to fish and is more visible at a higher pH. Ammonia is created through anthropogenic inputs, bacteria cell respiration, and the decomposition of dead cells. Due to being a gas, given time ammonia will volatilize from the water. At a lower pH, much of the ammonia is converted to ammonium (a nutrient for root bound plant life) and utilizes DO in the nitrification process.

Chloride

The chloride ion is an indicator of any salinity increases within a lake. Most fresh water aquatic species are sensitive to salinity changes.

Nitrate

Nitrate is the nitrogen product created through the nitrification of ammonium. Nitrate is a soluble form of the nutrient nitrogen and is utilized by phytoplankton.

Total Phosphorous

The total phosphorous provides a measure of both utilized and soluble phosphorous within water samples. Phosphorous is a required nutrient for plant growth and development.

Ortho Phosphorous

Ortho phosphorous is the soluble form of phosphorous that is utilized by free-floating aquatic plants (phytoplankton).

Kjeldahl N

Kjeldahl nitrogen or total Kjeldahl nitrogen (TKN) is a measure of the total concentration of nitrogen in a sample. This includes ammonia, ammonium, nitrite, nitrate, nitrogen gas, and nitrogen contained within organisms.

COD

Chemical Oxygen Demand (COD) is a measure of the total oxygen required to complete the chemical and biological demands of a sample.

Fish Tissue Analysis

Fish tissue is analyzed to examine potential exposure of humans to toxicants as well as the health of the aquatic food chain. In aquatic systems toxic contaminants can build up (or bioaccumulate) within animals at the top of the food chain. Contaminants (especially organic pollutants) are retained within the fat tissue of an organism, therefore in fish samples the lipid content is often measured.

Lake Code Designation

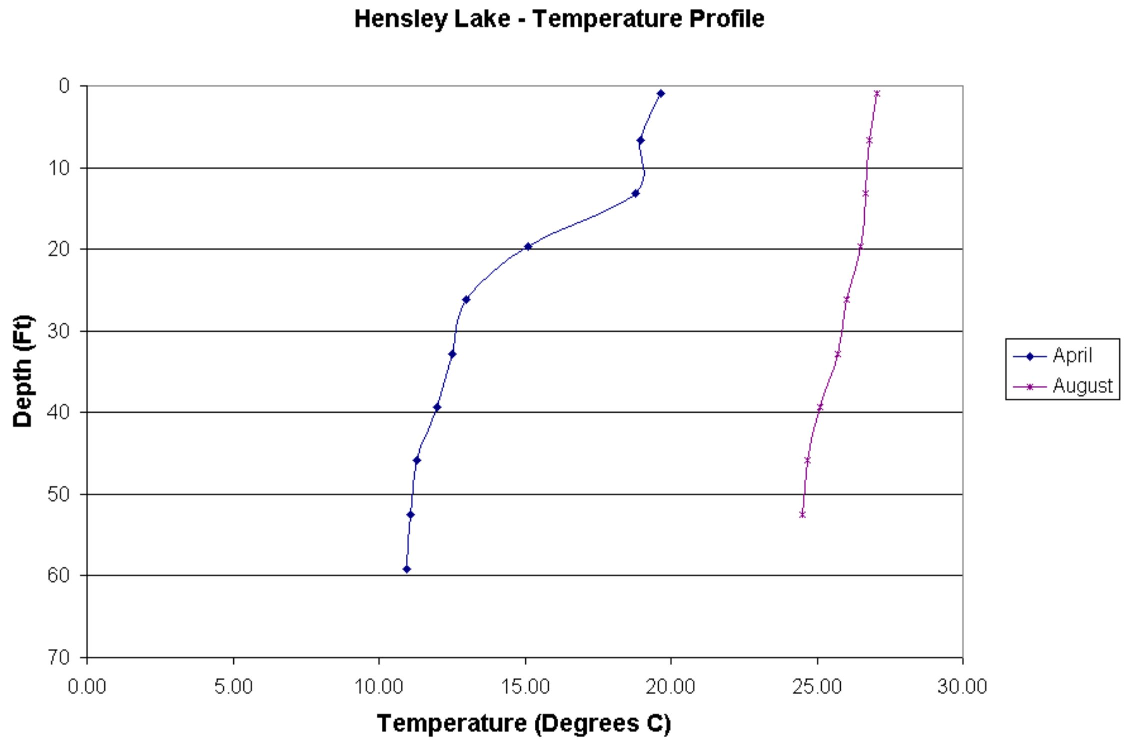
Laboratory Reports are provided in the previous sections.

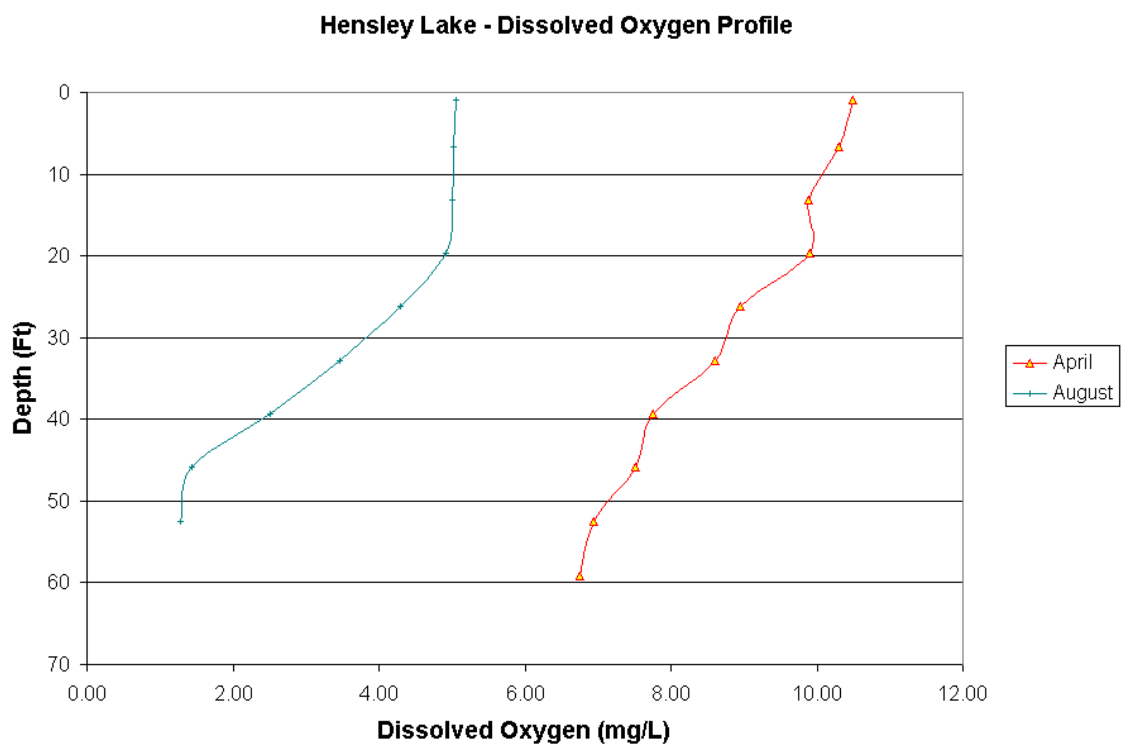
Sample ID is "XX-YY-ZZ"   where

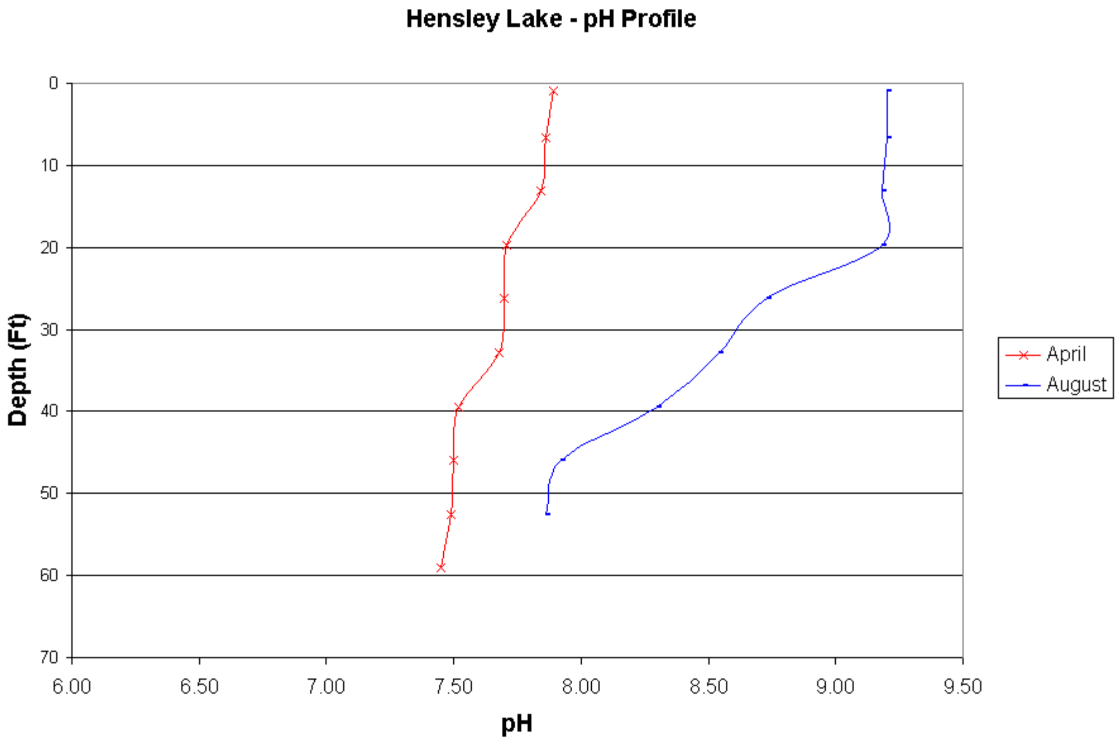
XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summar	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

Example: BB-SU-S is for a water sample taken from Black Butte in the Summer on the Lake's Surface.

Appendix B: Profile Data and Charts (Secchi Disc, Temperature, DO, and pH)


Hensley Lake - Temperature Profile
0
10
20
30
40
50
60
70
Depth (Ft)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Temperature (Degrees C)
April
August

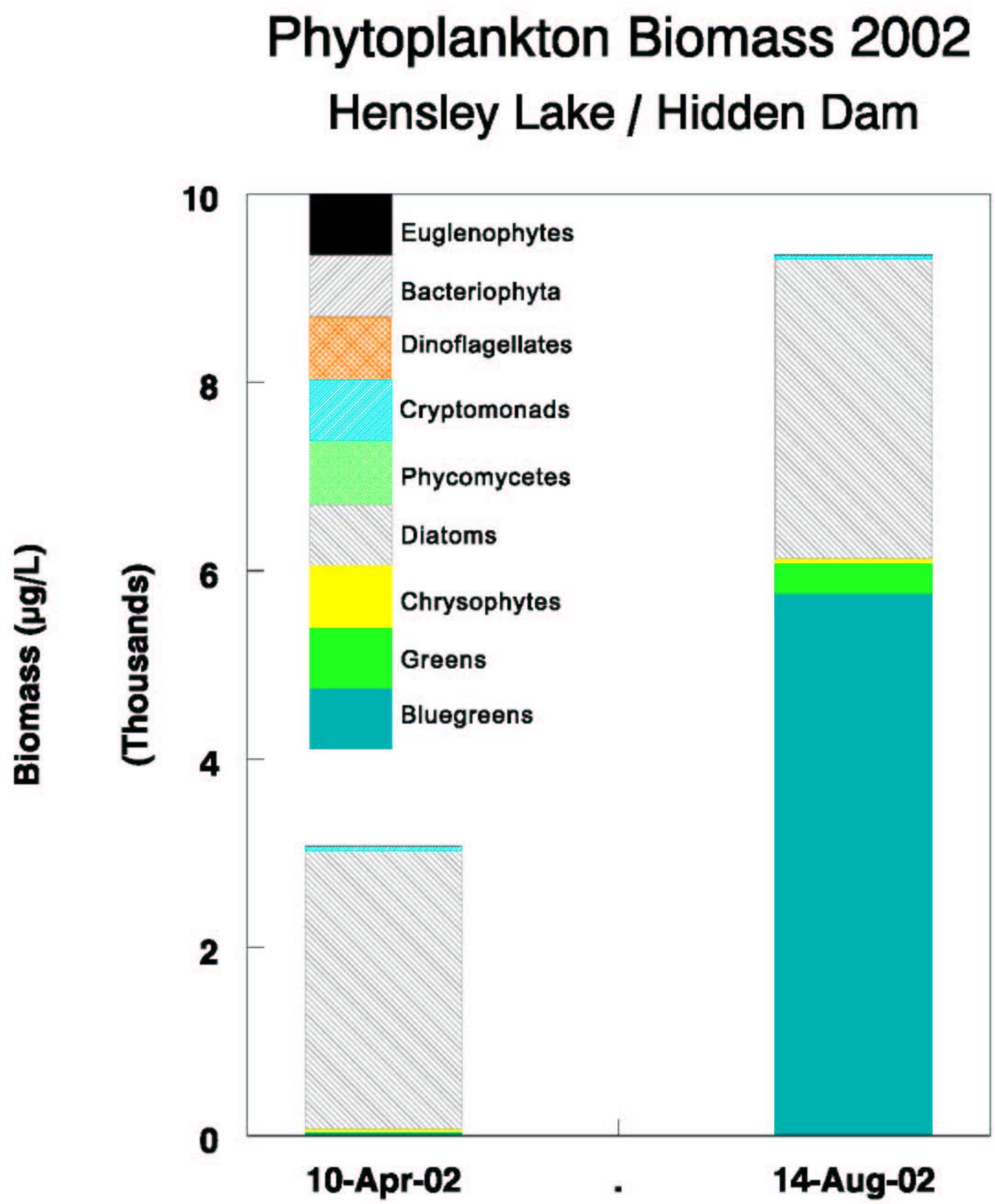

Hensley Lake - Dissolved Oxygen Profile
0
10
20
30
40
50
60
70
Depth (Ft)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
Dissolved Oxygen (mg/L)
April
August


Hensley Lake - pH Profile
Depth (Ft)
pH
0
10
20
30
40
50
60
70
6.00
6.50
7.00
7.50
8.00
8.50
9.00
9.50
April
August

LAKE HENSLEY					
Sample Location: Behind dam				**Date:** 4/10/02	
Observers: Tim McLaughlin				**Time:**	
Lake Elevation: 494.07					
Weather Conditions:					
Wind Speed: 20		**Precipitation:** 0		**Temp (F):** 60	
SECCHI Depth: 7 feet and 6 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
17.6	59.1	10.95	128	6.76	7.45
16	52.5	11.10	128	6.95	7.49
14	45.9	11.30	129	7.52	7.50
12	39.4	11.98	129	7.76	7.52
10	32.8	12.53	129	8.61	7.68
8	26.2	13.00	128	8.96	7.70
6	19.7	15.12	126	9.90	7.71
4	13.1	18.80	129	9.89	7.84
2	6.6	18.94	131	10.30	7.86
0.03	1	19.67	130	10.50	7.89
FRESNO (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
65.9	7.35		-	-	56
VISUAL OBSERVATIONS: Lots of floating algae-like material in lake.					

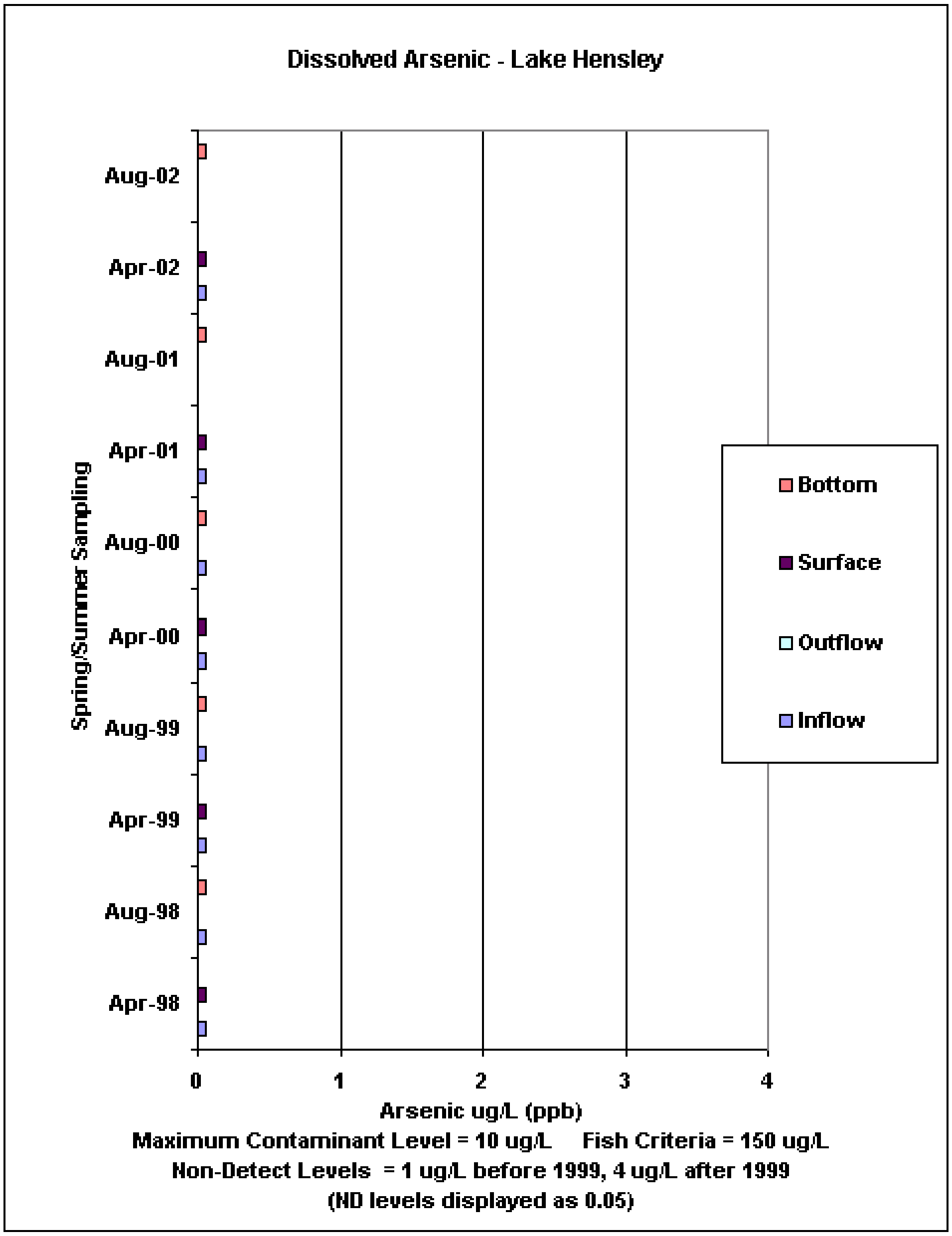
LAKE HENSLEY					
Sample Location: Behind dam				**Date:** 8/14/02	
Observers: Tim McLaughlin				**Time:** 9:45 am	
Lake Elevation: 469.57					
Weather Conditions:					
Wind Speed: 10		**Precipitation:** 0		**Temp (F):** 75	
SECCHI Depth: 4 feet and 5 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
15.8	52.5	24.49	186	1.29	7.86
14	45.9	24.67	186	1.43	7.92
12	39.4	25.10	186	2.51	8.30
10	32.8	25.72	187	3.47	8.54
8	26.2	26.01	186	4.30	8.73
6	19.7	26.49	186	4.91	9.18
4	13.1	26.66	186	5.01	9.18
2	6.6	26.80	187	5.02	9.20
0.03	1	27.07	187	5.05	9.20
FRESNO (Inflow) - DRY					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
-	-		-	-	-
VISUAL OBSERVATIONS: Strong hydrogen sulfide smell on lake surface.					

Appendix C: Phytoplankton Data and Charts

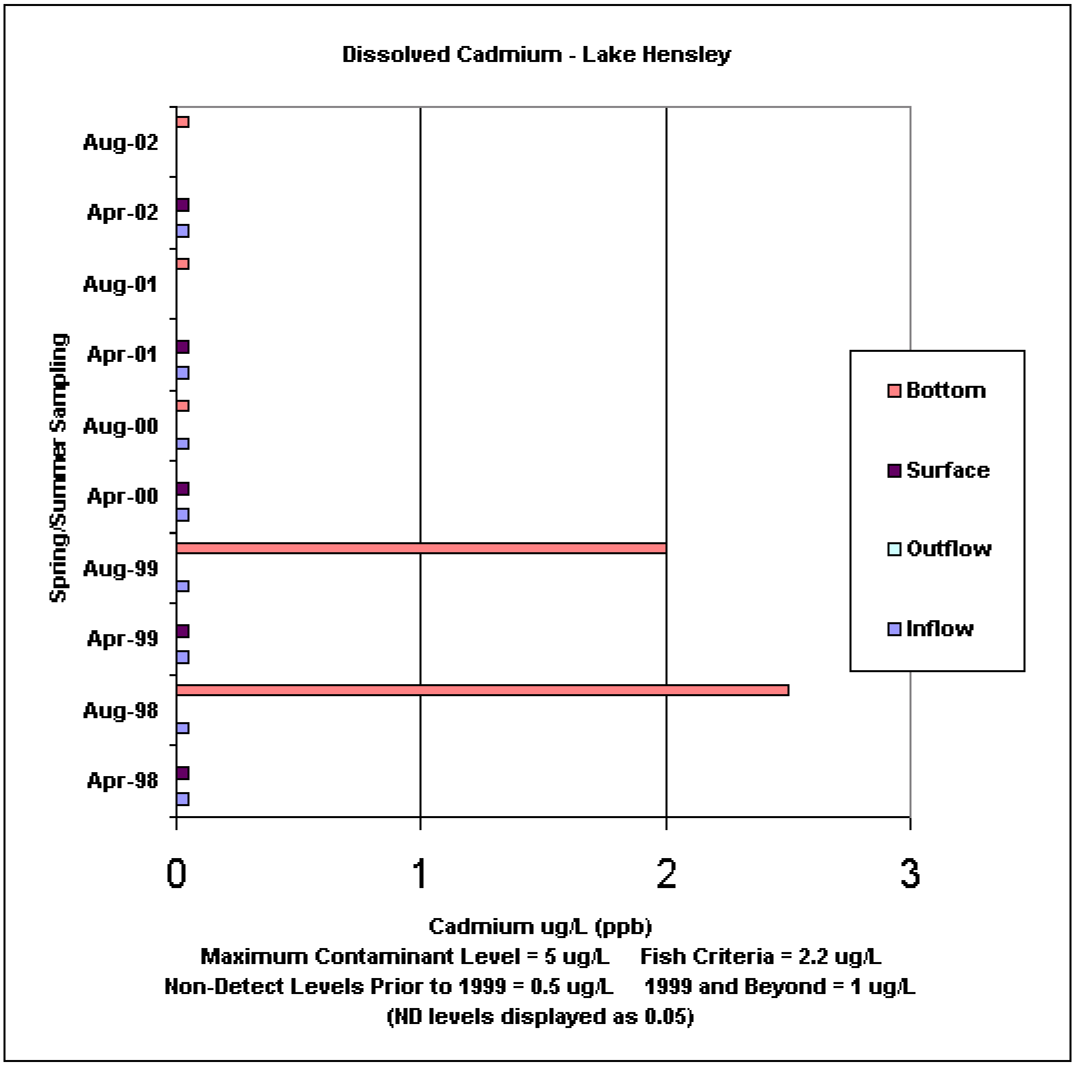


Phytoplankton Biomass 2002
Hensley Lake / Hidden Dam
Biomass (µg/L)
(Thousands)
10
8
6
4
2
0
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
10-Apr-02
.
14-Aug-02

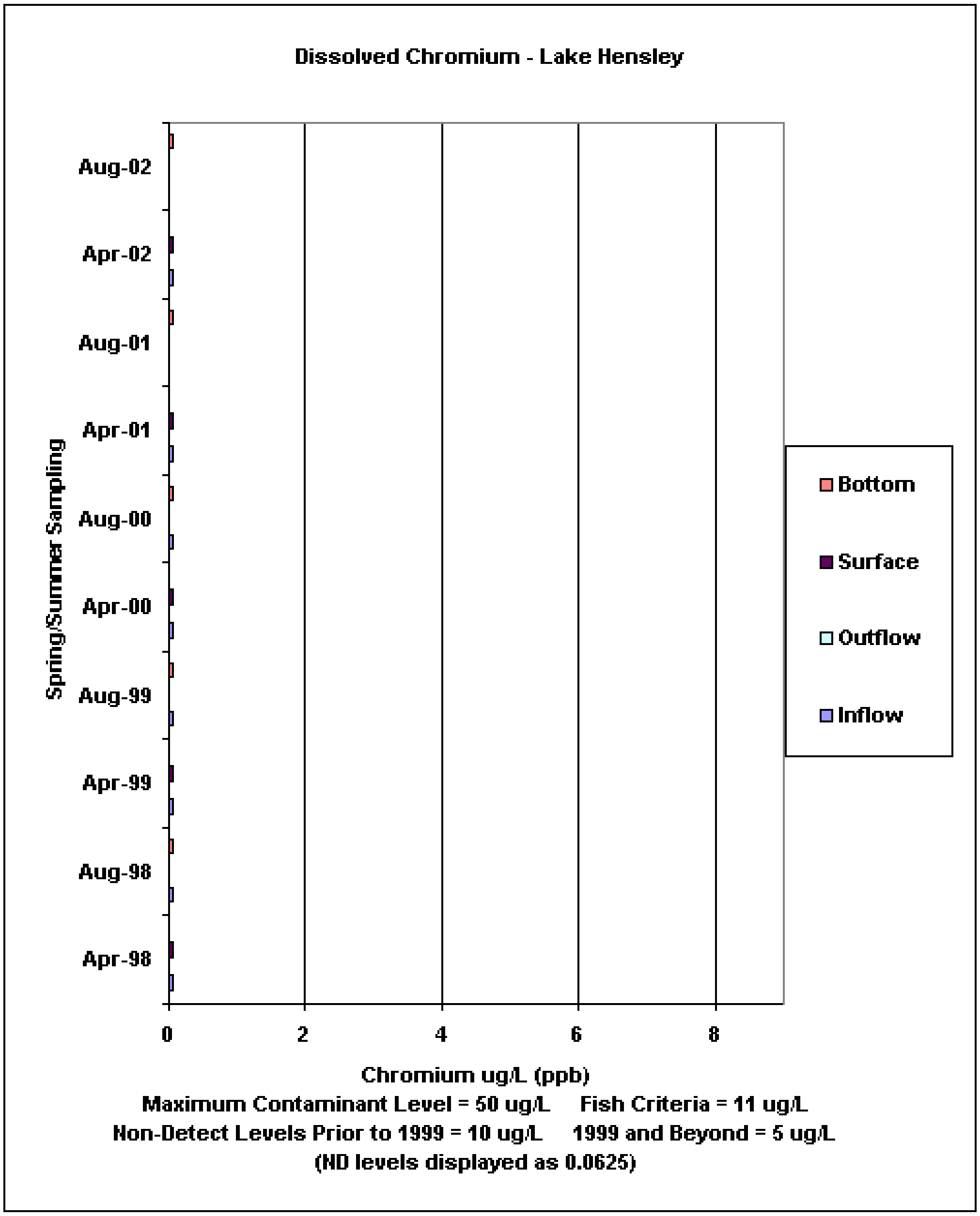
Appendix D: Metals Data and Charts



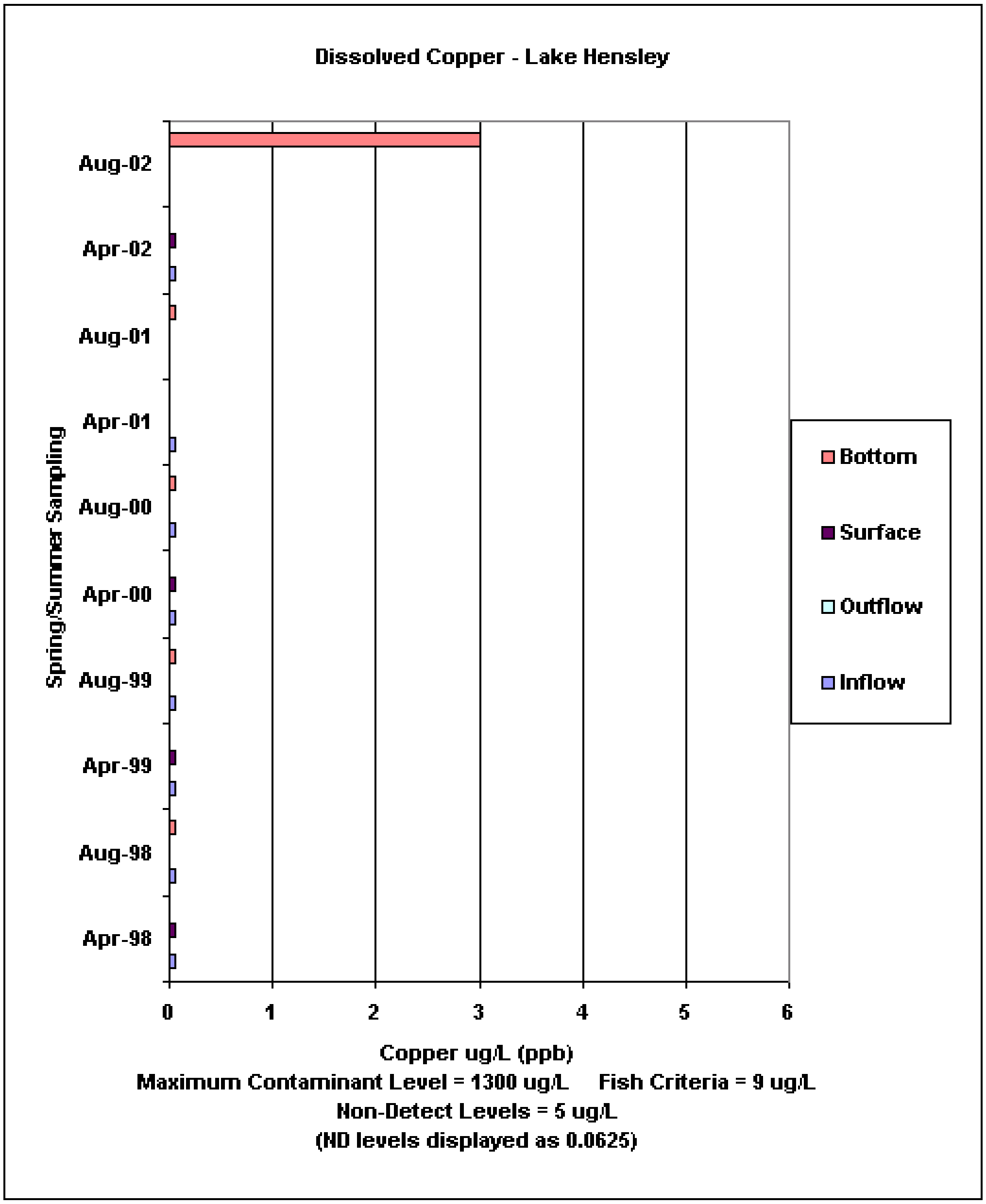
Dissolved Arsenic - Lake Hensley
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
Bottom
Surface
Outflow
Inflow
0
1
2
3
4
Arsenic ug/L (ppb)
Maximum Contaminant Level = 10 ug/L   Fish Criteria = 150 ug/L
Non-Detect Levels = 1 ug/L before 1999, 4 ug/L after 1999
(ND levels displayed as 0.05)



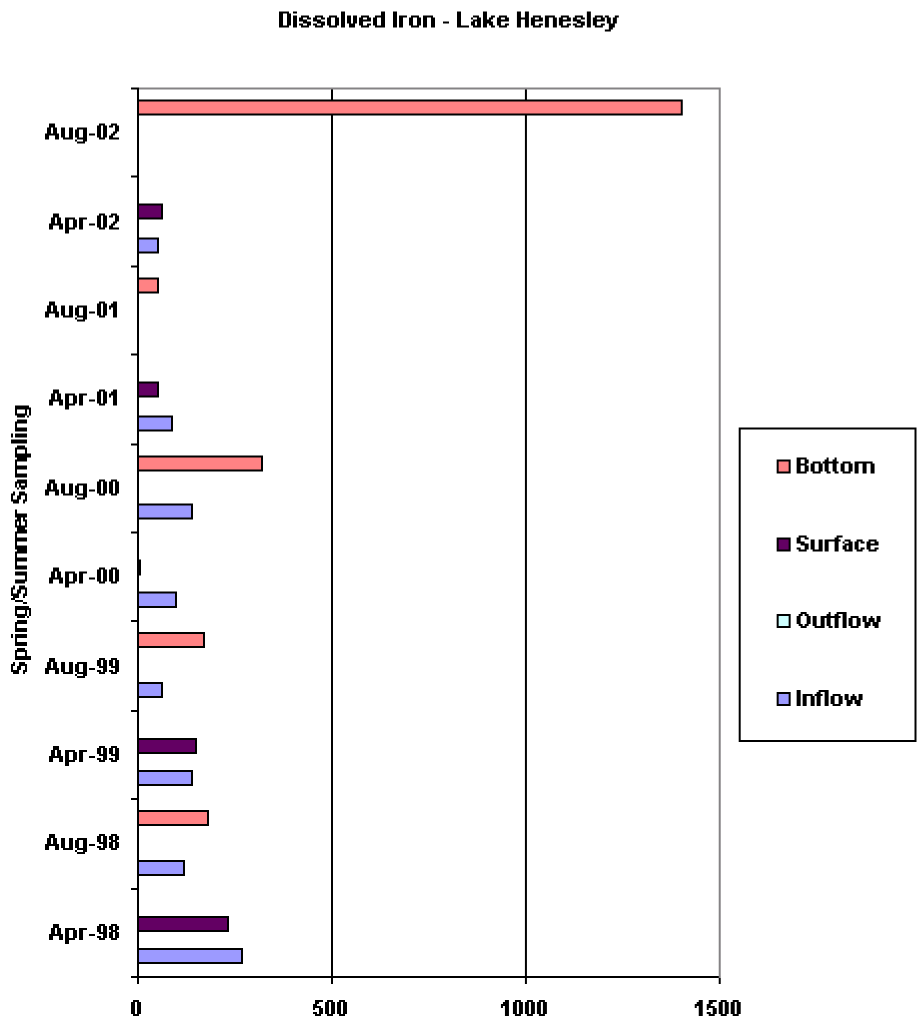
Dissolved Cadmium - Lake Hensley
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
Bottom
Surface
Outflow
Inflow
Cadmium ug/L (ppb)
Maximum Contaminant Level = 5 ug/L Fish Criteria = 2.2 ug/L
Non-Detect Levels Prior to 1999 = 0.5 ug/L 1999 and Beyond = 1 ug/L
(ND levels displayed as 0.05)



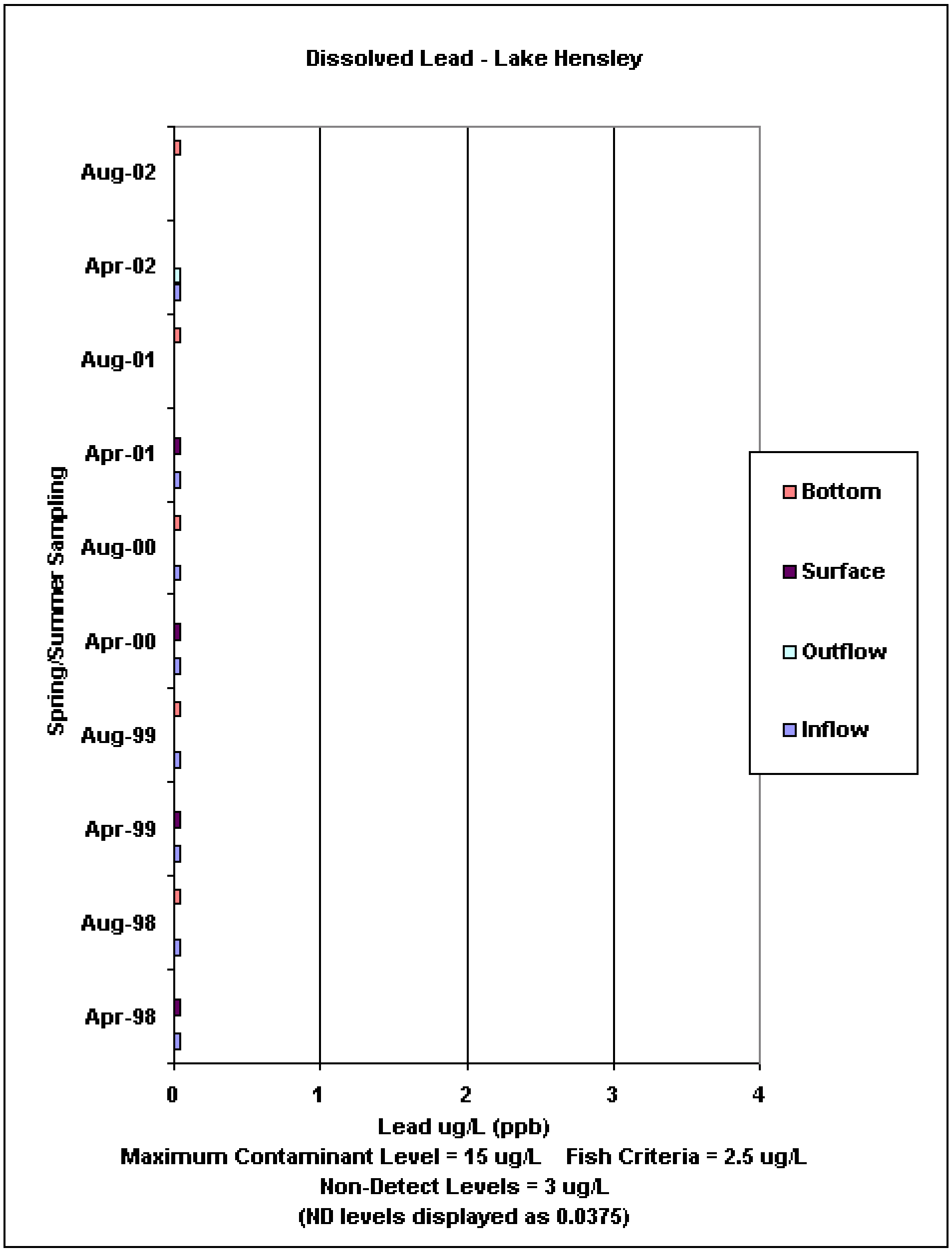
Dissolved Chromium - Lake Hensley
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
Bottom
Surface
Outflow
Inflow
Chromium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L
Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L
1999 and Beyond = 5 ug/L
(ND levels displayed as 0.0625)



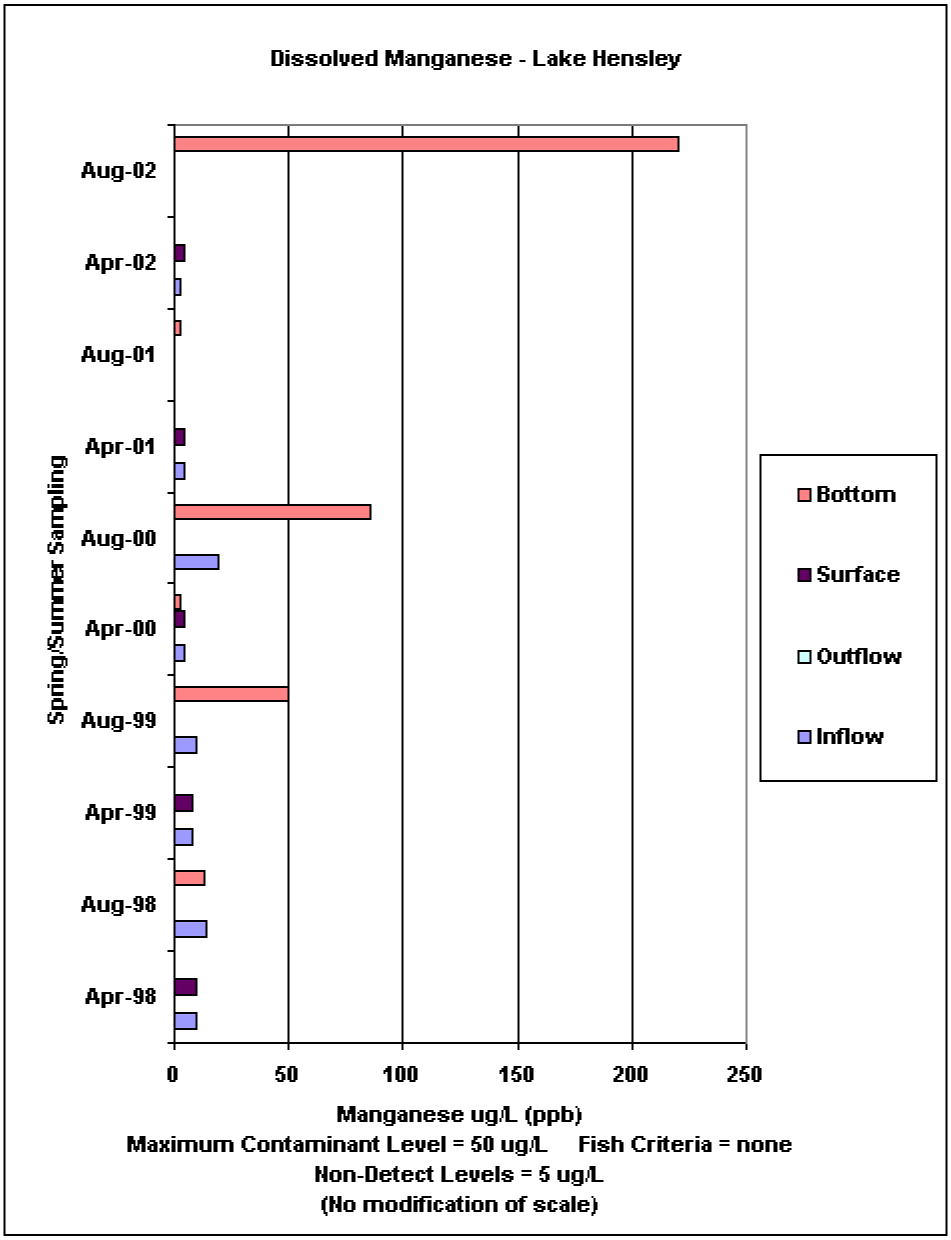
Dissolved Copper - Lake Hensley
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
5
6
Bottom
Surface
Outflow
Inflow
Copper ug/L (ppb)
Maximum Contaminant Level = 1300 ug/L Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L
(ND levels displayed as 0.0625)



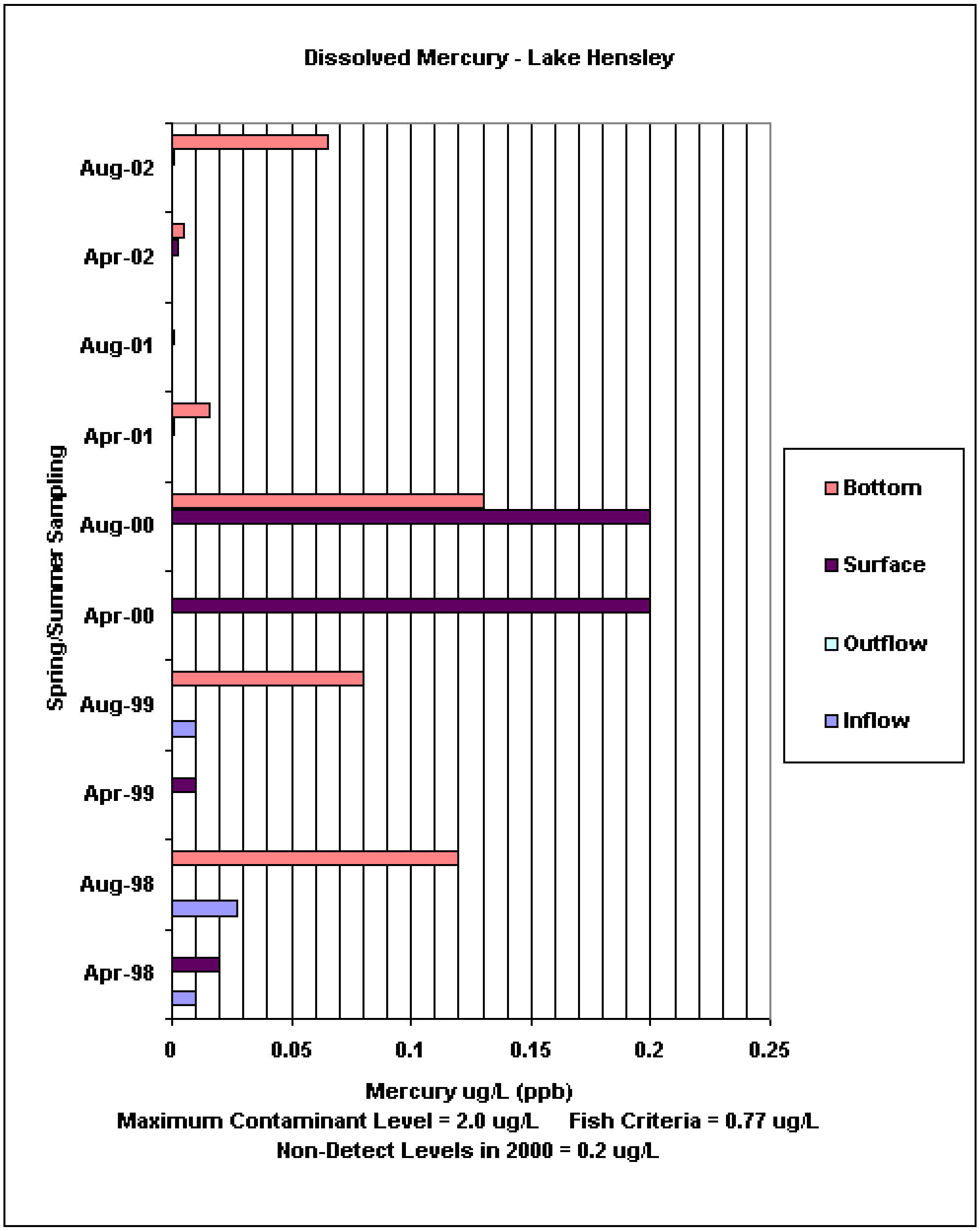
Maximum Contaminant Level = 300 ug/L   Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L   1999 and Beyond = 50 ug/L
(No modification of scale)

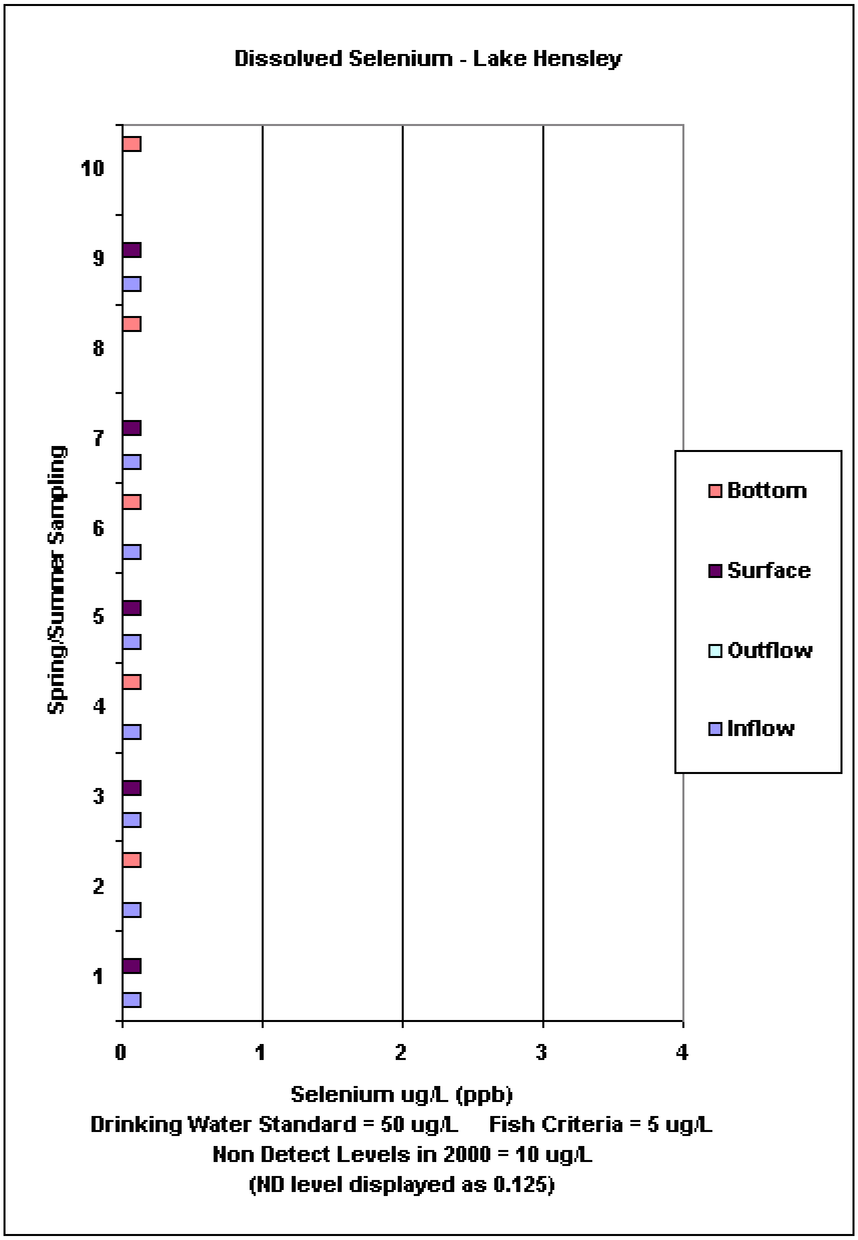


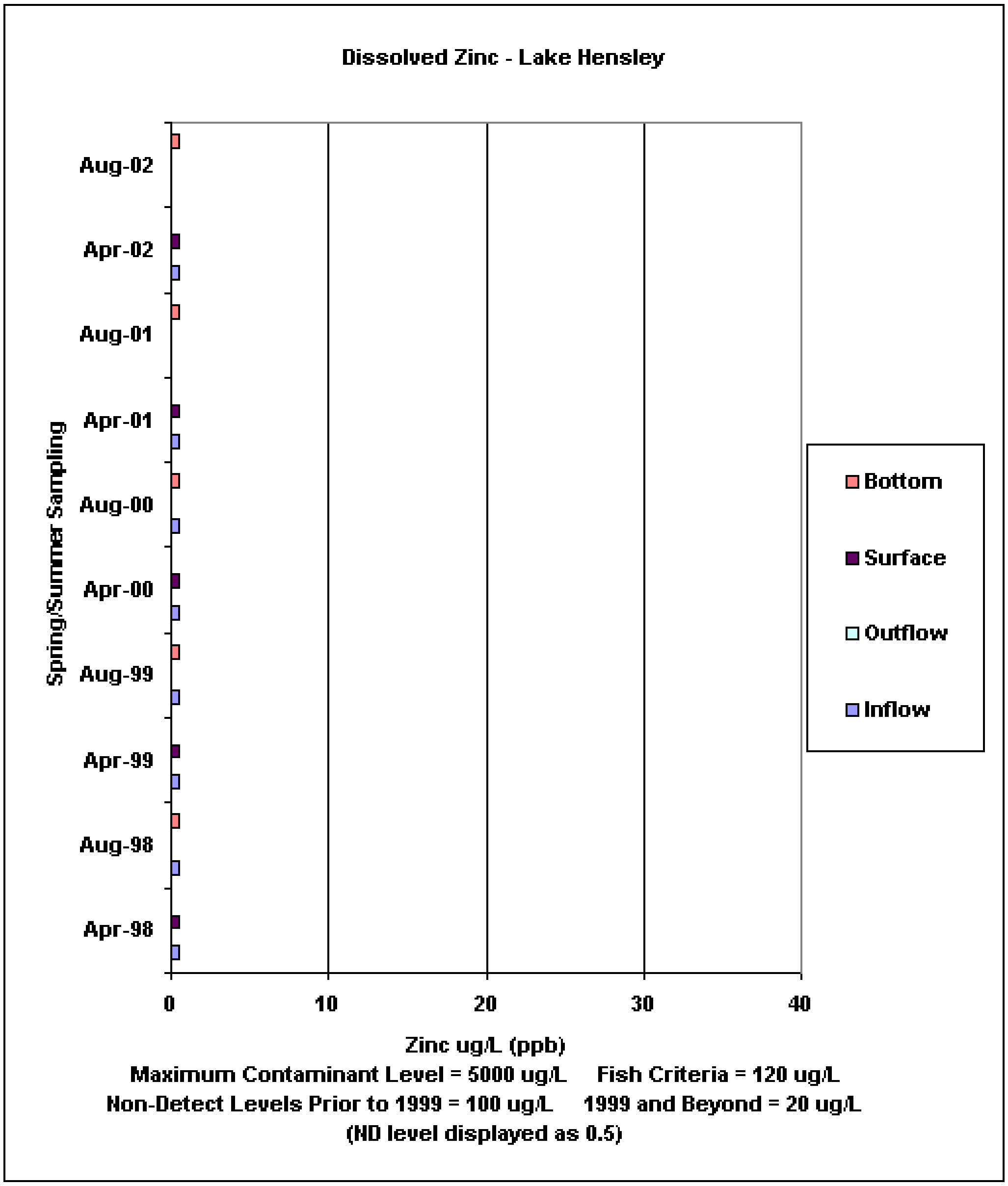
Dissolved Lead - Lake Hensley
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
Bottom
Surface
Outflow
Inflow
Lead ug/L (ppb)
Maximum Contaminant Level = 15 ug/L Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L
(ND levels displayed as 0.0375)



Dissolved Manganese - Lake Hensley
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
50
100
150
200
250
Bottom
Surface
Outflow
Inflow
Manganese ug/L (ppb)
Maximum Contaminant Level = 50 ug/L   Fish Criteria = none
Non-Detect Levels = 5 ug/L
(No modification of scale)


Dissolved Mercury - Lake Hensley
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.05
0.1
0.15
0.2
0.25
Mercury ug/L (ppb)
Maximum Contaminant Level = 2.0 ug/L Fish Criteria = 0.77 ug/L
Non-Detect Levels in 2000 = 0.2 ug/L
Bottom
Surface
Outflow
Inflow


Dissolved Selenium - Lake Hensley
Spring/Summer Sampling
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
Bottom
Surface
Outflow
Inflow
Selenium ug/L (ppb)
Drinking Water Standard = 50 ug/L
Fish Criteria = 5 ug/L
Non Detect Levels in 2000 = 10 ug/L
(ND level displayed as 0.125)



Dissolved Zinc - Lake Hensley
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
10
20
30
40
Bottom
Surface
Outflow
Inflow
Zinc ug/L (ppb)
Maximum Contaminant Level = 5000 ug/L Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L 1999 and Beyond = 20 ug/L
(ND level displayed as 0.5)

Appendix E: Inorganic Sample Data

Inorganic Results (mg/L) For surface lake waters (spring)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity		60	40	50	60	30	40	70	80	20		100
Ammonia		<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Chloride		21	2	21	4	4	3	<1	6	5		4
Nitrate		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1		<0.1
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Sulfate		5.3	2.6	4.2	8.9	2	1	8.2	9	2.1		4.7
Kjeldahl N		0.6	0.1	0.4	0.2	<0.1	0.3	0.2	0.2	0.2		<0.1
COD					<50							
Tot Solids		120	70	100	110	60	78	100	120	21		150

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	100	70	40	50	20	30	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	13	25	3	21	<1	<1	4	<1	6	4	3	2
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	
Sulfate	18	2.1	2.3	3	2.8	1.9	0.8	8.8	11	1.6	11	3.5
Kjeldahl N	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1
COD	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	170	130	59	110	60	60	90	110	150	30	130	90

Inorganic Results (mg/L) For surface lake waters (summer)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	140	70	40	50	50	40	70	90	80	10	80	110
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
Chloride	16	26	4	19	6	5	5	5	9	3	5	8
Nitrate	<0.1	1.5	<0.1	1.3	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1
Total P	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	16	4.1	3.6	3.5	5.9	2	0.7	7.4	14	1.6	6.4	4.4
Kjeldahl N	<0.1	2.7	<0.1	0.4	0.4	0.3	<0.1	0.2	<0.1	<0.1	0.2	0.6
COD	<50	60	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	200	190	50	120	98	80	80	120	120	52	100	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	90	40		60	40	80	100	130	20	110	180
Ammonia												
Chloride	16	490	5		10	8	3	5	14	4	5	22
Nitrate												
Total P												
Ortho P												
Sulfate	16	4.5	3		9.8	3.2	<0.5	6	14	2.7	5.4	8.7
Kjeldahl N												
COD												
Tot Solids	200	1300	50		140	100	100	150	200	50	140	280

Appendix F: MTBE Table

2002 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2002 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	2		2		<2		<2		
Eastman	5				<2				
Englebright	3		3		10		10	10	
Hensley	3		3		3		3		
Isabella	<2	<2	<2	<2	<2	<2	<2	<2	
Kaweah	2		2	<2	8		6	6	
Martis Cr.	<2				<2				
Mendocino	<2				<2				
New Hogan	<2				3				
Pine Flat	<2		<2		2		2		
Sonoma		3	<2		<2		2		
Success	4		4	4	11	12	11	11	

Notes:

1. Non-Detect is indicated by "<2" since the Reporting Limit is 2 ppb or 0.002 ppm.

2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.

3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.

4. For 2002, the number of MTBE water sampling at each lake is based on last year's lab results.

5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was historically non-detectable. The 2002 results of non-detectable levels were similar except Lake Eastman and New Hogan now reported low, detectable levels of MTBE.

6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because of historically low detectable levels of MTBE.

7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because of historically higher MTBE being found. The 2002 results were similar except Isabella now reported non-detectible levels.

8. In 2001, very high MTBE levels were reported at Lake Isabella during the Spring (18 ug/L near the marina) . During Spring 2000, Lake Isabella reported 21 ug/L. The 2002 results indicate that the previous MTBE problem near the marina was not visible during the Spring 2002 sampling event, and may have been rectified.

H. Fish tissue analysis table

2002 Fish Tissue Results

The following table provides an overview of the lab results for the 2002 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conductng the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The California OEHHA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Mercury Total ppm	FDA Criteria
Black Butte	Sm M Bass	Composite (3)	6/12/02	0.24	0.26	1 ppm
Eastman	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Englebright	Note 5	N/A	N/A	N/A	N/A	
Hensley	Black Bass	Composite (3)	4/23/02	<0.10	0.72	1 ppm
Isabella	Black Bass	Composite (3)	6/4/02	0.20	0.21	1 ppm
Kaweah	Sm M Bass	Composite (3)	7/14/02	0.11	0.53	1 ppm
Martis Cr	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Mendocino	Note 6	N/A	N/A	N/A	N/A	
New Hogan	Lg M Bass	Single (1)	6/3/02	<0.10	0.34	1 ppm
Pine Flat	Note 4	--------------------	-----------	----------	-----------	< Mon 01
Sonoma	Note 6	N/A	N/A	N/A	N/A	
Success	Black Bass	Composite (3)	4/15/02	<0.10	0.18	1 ppm

Notes:

9. Non-Detect is indicated by "<0.02". The lab Detection Limit for mercury is 0.02 ppm.
10. Total Mercury was reported in mg/g or ppm.
11. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.
12. The fish tissue program was terminated at Eastman and Martis Creek in 2001 and in Pine Flat in 2002 due to low total mercury results. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout). For Pine Flat total mercury was 0.21 ppm in 2000 (composite of three Sacramento Sucker fish) and 0.23 in 2001 (composite of three spotted bass).

13. Due to seasonal conditions, a fish could not be successfully collected at Lake Englebright. Another attempt will be accomplished for the 2003 report.
14. Fish were not collected at Mendocino or Sonoma due to communication difficulties.

The above 2002 total mercury results indicate only Hensley is higher than average. However, in 2001, the total mercury results were only 0.30 ppm for Hensley (small mouth bass). The 2003 fish tissue program should provide additional data. EPA fact sheet on fish advisories (EPA-823-F-99-016) indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.

Annual Water Quality Report

LAKE KAWEAH

Water Year 2002

Written by
John J. Baum
Water Quality Engineer
U. S. Army Corps of Engineers
Sacramento District
January 2003

TABLE OF CONTENTS

Lake Kaweah

I. Purpose

This report is part of an environmental monitoring program that began at Lake Kaweah in April 1974. The monitoring program was implemented to determine the suitability of water quality in the lake for both recreation and environmental health and to satisfy the Department of Army Engineering Regulation 1110-2-8154, “Water Quality and Environmental Management for Corps Civil Works Projects”.

II. Brief Description of Lake Kaweah

Lake Kaweah is located in central California, 20 miles east of Visalia. The lake is nestled in the southern Sierra Nevada foothills and is surrounded by grasslands and blue oaks. The lake was formed by the construction of Terminus Dam on the Kaweah River. Construction of the dam was completed in 1962 by the U.S. Army Corps of Engineers. During the spring run-off season the lake stores 143,000 acre-feet of water. Energy production was added in 1990 with the construction of the Terminus Power Plant. The new hydroelectric plant produces an average of 40 million kilowatt-hours of electricity annually. Since being built by the US Army Corps of Engineers for flood control and irrigation, the lake has become a popular destination for recreation. Summers are warm and the winters mild, allowing for year-round activities.

Water quality monitoring by the United States Army Corps of Engineers (USACE) began at Lake Kaweah in April 1974. Generally there are two sample events a year, spring (April) and late summer (August). Since the start of the monitoring program, a water quality report is produced yearly to list results and address any concerns of the previous water year.

Generally Lake Kaweah has a depth of < 100 ft during the sampling events and is considered a slightly eutrophic (nutrient rich) lake when characterized by its clarity. One of the common characteristics of eutrophic lakes such as Lake Kaweah is that during warm late summer months the lower depths are low in dissolved oxygen (DO). Additionally Lake Kaweah is warm (>20ºC) in the late summer. Due to both the low DO concentrations and high temperatures, warmwater fish species are best suited to survive in the lake. Warmwater fish species include bass, carp, perch, bluegill, crappie, and catfish. Another characteristic of eutrophic (nutrient rich) lakes is their low water clarity due to algal blooms. In shallow regions, sediments suspended by wind action are another impairment to clarity. Water clarity is often measured in terms of Secchi Disc depth or SD (Appendix A). Historically the water clarity in Lake Kaweah has been low (Average SD = 6.4 feet), but 94 % of the samples meet the recreational goal of 4 feet or greater (Figure 1). In 2001 both the spring and the late summer SD measurements were above the goal of 4 feet (2001 spring SD = 10.5 feet and 2001 Late summer SD = 5.67 feet).

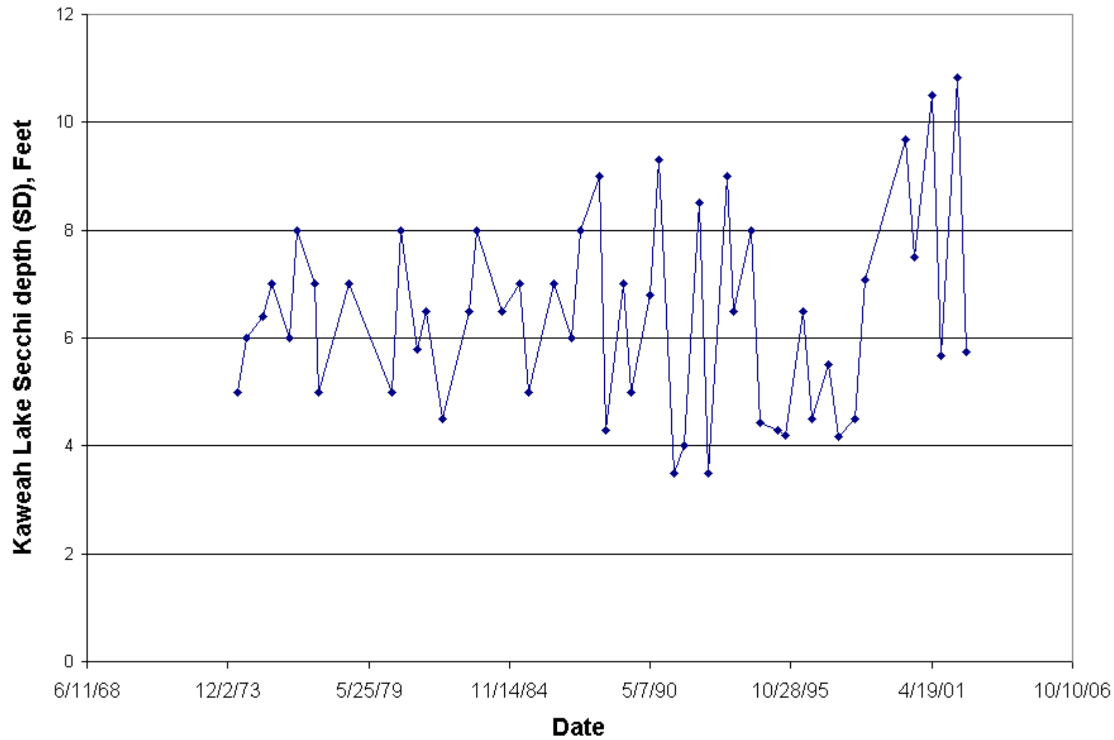


Figure 1. Historical Secchi Depth Values at Lake Kaweah (2002 values included).

The 2001 Water Quality Report listed dissolved mercury, mercury in fish tissue, and MTBE as significant contaminants of concern in Lake Kaweah. Since none of the mercury sample results were above the fish criteria concentration (0.77 ppb), nor the MCL for mercury (2 ppb), the concern over mercury concentrations may have been unfounded. Although aqueous concentrations of mercury in the lake were below criteria for concern, there were legitimate concerns about the amount in fish within the lake. In 2000, the composite fish tissue sample resulted in a concentration of 0.68 ppm, which was below the U.S. FDA fish advisory of 1 ppm, but above the California Office of Environmental Health Hazard Assessment (OEHHA) action level concentration (0.3 ppm Hg) to continue monitoring. In 2001, the concentration of mercury within fish tissue was found to be lower than the previous year (0.4 ppm), but concerns about the concentration of mercury in fish remained. While concentrations of MTBE in the spring of 2001 were just above the detection limit of 2 ppb (2001 MTBE Spring = 3 ppb), values were found to be higher during the summer. Concentrations of MTBE near the marina and in the center of lake Kaweah were 6 ppb.

III. Sample Summaries for this year.

Introduction

The following general summaries are split into their respective sample types. Each type of sample summary includes a discussion of both the spring (April) and late summer (August) samples to better examine trends within the current year. The types of parameters monitored this year include: Secchi Disc depths, water column profiles (temperature, DO and pH), phytoplankton characterization, metals concentrations, MTBE concentrations, inorganic characterization (alkalinity, phosphorous, nitrogen, etc..), and fish mercury concentrations. For a more detailed explanation of the importance for each type of sample, please see Appendix A.

SECCHI DEPTH

The Secchi Disc depth values found during the spring and late summer sampling were similar to previous events. Traditionally the lake varies in its clarity. More often the clarity is better in the spring than in the late summer, but sometimes late summer is clearer. In spring the water clarity was higher and had a SD of 10.83 feet. The late summer SD of 5.75 feet was above the recreational goal of 4 feet and an improvement from last year (Summer 2001 SD = 5.67) (Appendix B). One thing to note is the consistent improvement over the last three years in the SD values (Figure 1).

TEMPERATURE VALUES

The temperature profiles for Lake Kaweah are indicative of a lake that was stratified during both sampling events. The lake is well stratified in the spring, but the hypoliminion (lower layer) was almost gone by the warm temperatures of late summer. In past years the summer temperature profile shows that no deep layer remains later in the summer and the lake was well mixed (see 2001 Lake Kaweah Water Quality Report). The difference in the depth of the lake between the spring and late summer sampling events was large (spring depth = 137.6 feet, late summer depth= 65.6 feet). While the average temperatures were very different near the surface (Surface spring average temp. = 16.49 ºC, Surface late summer average temp.= 25.44 ºC), the temperatures near the bottom were similar due to the buffering effects made possible by the small hypolimnion remaining (Bottom spring temp. = 9.59 ºC, Bottom late summer temp.= 12.52 ºC). Kaweah Lake’s temperature was moderated in late summer 2002 due to the existence of a deep, cooler water area to buffer it from the warm summer air temperatures. Although this year summer lake temperatures were cooler, historically the warmth of the water during the summer limits the ability of Lake Kaweah to support coldwater fish species year round. For detailed results obtained during the sampling events, please see Appendix B.

DISSOLVED OXYGEN

The dissolved oxygen (DO) concentration differs greatly from spring to late summer. In the spring DO concentrations are supersaturated (DO spring surface = 12.67 mg/l DO) near the surface and within the expected range at the bottom (DO spring bottom = 8.07 mg/L) of the lake. DO concentrations near the surface are supersaturated (At saturation, DO = 9.7 mg/l at 16.5 ºC) due to phytoplankton photosynthesis. DO concentrations in the late summer are much lower and have a steady gradient from near the surface (DO summer surface = 4.31 mg/l) to the bottom of the lake (DO summer bottom=0.79 mg/l). The low DO values at the bottom of the lake are associated the decomposition of waste materials. Decomposition rates are slightly accelerated due to elevation of water temperatures in the later summer. Fish species that require greater than 5 mg/l DO at cooler water temperatures (< 20ºC) would be unlikely to survive year round in Lake Kaweah. For detailed results obtained during the sampling events, please see Appendix B.

PH LEVELS

In the spring sample event, pH values in the lake were slightly basic (pH = ~7.74) throughout the water column. The pH values in the late summer profile varied widely. The pH was more basic towards the surface and middle waters (max pH = 7.37) and slightly acidic at the bottom (pH = 6.88). The lower pH values at the bottom of the lake increase the likelihood that higher soluble metal concentrations will be in lake bottom samples. For detailed results obtained during the sampling events, please see Appendix B.

PHYTOPLANKTON

In the spring sample, the algal biomass within the lake was much lower (Biomass = 837.43 ug/L) when compared to spring 2001 (2001 Spring biomass = 4216.22 ug/L). In spring 2001 and spring 2002, diatoms were the most dominant species. In late summer the opposite trend occurred and the phytoplankton population was much lower in summer 2001 (2001 Summer Biomass = 828.50 ug/L) than summer 2002 (Biomass = 2655.39 ug/L). Diatoms were the most dominant species during the 2002 and 2001 late summer sampling events. For detailed results obtained during the 2002 sampling events, please see Appendix C.

METALS

Most of the dissolved heavy metal samples did not exceed the maximum contaminant level (MCL) or the freshwater fishery criteria during either the spring or summer except for dissolved manganese.

In late summer 2002, water at the bottom of the lake had a manganese concentration of 85 ppb. This was above the secondary Maximum Contaminant Level (MCL manganese = 50 ppb). Due to the manganese secondary MCL being aesthetic quality criteria and not indicative of toxic effects, concentrations of manganese are not a concern at this time.

Dissolved mercury concentrations in late summer samples at the bottom of the lake were well below the fish criteria limit of 0.77 ppb. The concentrations of dissolved mercury in bottom lake samples for spring and late summer sampling events were 0.003 ppb and 0.0043 ppb respectively. For detailed results obtained during the sampling events, please see Appendix D.

MTBE

Concentrations for MTBE around the lake were found to be ~3 ppb during the spring but increased in late summer sampling to a maximum of 8 ppb near the dam. Concentrations near the marina and in the center of the lake didn't change in summer samples from 2001 to 2002 (6 ppb). For detailed results obtained during the sampling events, please see Appendix F.

INORGANIC ANALYSIS

Results for the Spring and late Summer inorganic analysis were within historic and expected ranges, and the only parameter to note is alkalinity. The alkalinity results for Spring (40 mg/L CaCO3) and Summer (40 mg/L CaCO3) at Lake Kaweah were some of the lowest results for the lakes monitored by the USACE Sacramento District. Although the alkalinity values were low, they were consistent with the last couple of years. For detailed results obtained during the 2002 sampling events, please see Appendix E.

FISH TISSUE ANALYSIS

Fish tissue analysis for total mercury was performed on a composite sample composed of tissue from three small mouth bass collected in July 2002. The composite sample had a resulting total mercury concentration of 0.53 ppm. This is below the U.S. F.D.A. criteria for a fish advisory (1 ppm), but higher than the California Office of Environmental Health Hazard Assessment's (OEHHA) screening value for monitoring (0.3 ppm). The 2002 composite sample had a higher mercury concentration than the 2000 event (0.40 ppm), but lower than the 2001 (0.68 ppm) composite sample. For detailed results obtained during the sampling events, please see Appendix G.

IV. Conclusions

Lake Kaweah is a moderately eutrophic lake that can support warmwater fish species. Coldwater fish that require temperatures below 20°C and dissolved oxygen concentrations greater than 5 mg/L may have difficulties surviving the summer conditions at Lake Kaweah.

The contaminant of concern in Lake Kaweah during 2002 was mercury in fish tissue. Fish tissue mercury concentrations were higher than other lakes (0.53 ppm). Monitoring fish in the next year will hopefully shed more light on the status of mercury in the lake.

V. References

North American Lake Management Society (1990). *Lake and Reservoir Restoration Guidance Manual*, EPA 440/4-90-006, U.S. Environmental Protection Agency, Washington, DC.

Novotny, V., and H. Olem (1994). *Water Quality: Prevention, Identification, and Management of Diffuse Pollution*, Van Nostrand Reinhold, New York, New York.

Tchobanoglous, G., F. L. Burton, and H. D. Stensel (2003) *Wastewater engineering: treatment and reuse / Metcalf & Eddy, Inc*., McGraw-Hill, Boston, MA.

Welch, E.B. (1992) *Ecological Effects of Wastewater: Applied limnology and pollutant effects,* Chapman and Hall, Cambridge University Press, Great Britain.

Wetzel, R.G. (1975). *Limnology*, W.B. Saunders Company, Philadelphia, PA.

VI. Appendices

Appendix A: Glossary of Sample Types

Glossary of Sample Types

This glossary of sample types is intended to provide a general background and indicate the importance of each sample in determining water quality. These are meant to be brief and basic. If a further explanation is desired please refer to the list of references provided in this report.

Secchi Depth

One of the oldest and easiest methods to determine lake clarity is the Secchi depth (SD). The Secchi depth is determined by dropping a Secchi disc into a water body and determining the depth that it is last visible from the surface of the water. Secchi discs are generally white and 20 cm in diameter. Secchi depth values are most impacted by the light intensity at the time of sampling and the scattering of light by solid particulates within the water column. Algal growth (phytoplankton) and sediment re-suspension are often major constituents of solid particulates within the water column. Secchi depth values can be used to estimate the Trophic state or the nutrient levels within the lake. The more nutrients are available, the larger likelihood of algal blooms that limit water clarity. Due to recreational concerns for safety, the goal for Secchi depth values is four feet or greater.

Temperature Profiles and Data Points

The temperature profile of a lake provides information how a lake is operating and the potential for aquatic biota to live within the lake. The temperature profile is a direct indicator if a lake is stratified. Stratification in lakes is created generally by temperature affecting the density of water molecules. Stratification is usually indicated by a region of similar temperature nearer the surface of the water (epilimnion), then a region of temperature transition (metalimnion), to another layer of nearly constant temperature at the bottom of the lake (hypolimnion). Each layer in a stratified lake is important, but the existence of a hypolimnion can drastically impact how well a lake can handle warmer temperatures such as those found in northern California during the summer. The hypolimnion acts as a buffer against large temperature shifts. The nature of dam operation is that water is discharged near the bottom, releasing the hypolimnion, and eliminating stratification. This operation limits the ability of reservoirs to regulate their temperature during the summer months. Stratification isn't always desirable. When a lake isn't stratified and is instead well mixed, the required nutrients near the bottom of the lake become available to phytoplankton for growth. Temperatures within lakes also indicate which species of fish will survive within a lake. Coldwater species of fish require temperatures below 20 degrees C in order to spawn and survive. If a lake is often above 20 degrees C, then only warmwater fish species will survive.

Dissolved Oxygen (DO) Concentration Profiles

DO is required by organisms for respiration and for chemical reactions within lake waters. The recommended level for DO for most aquatic species survival is 5mg/L. In lakes, biota waste (detritus) falls to the bottom of the lake to be utilized by bacteria. The

bacteria need oxygen and will deplete levels near the bottom of a lake, especially during warm temperature, high respiration conditions. For nutrient rich (eutrophic) lakes more organisms will grow, create wastes, and cause oxygen depleted regions at the lowest areas. Under these conditions only aquatic species that can survive low DO conditions in warm water near the surface will survive.

PH Profiles

The pH profiles of the lakes indicate the potential for certain chemical reactions to occur. In high pH (greater than pH = 7 or basic) aquatic systems, metal pollutants tend to form into insoluble compounds that fall onto the lake floor. In low pH (less than pH = 7 or acidic) systems or areas metal ions become soluble and available for uptake into aquatic organisms. Other compounds like ammonia that are introduced into a low pH aquatic environment will transform into soluble nitrate and be utilized by organisms.

Phytoplankton Analysis

Phytoplankton analysis indicates the health, nutrients, and biodiversity within a lake. Lakes that have few nutrients available (Oligotrophic) will generally have a much lower quantity of phytoplankton (high Secchi depth) but the number of phytoplankton species seen will be large. In a lake that is nutrient rich (eutrophic) there are generally large phytoplankton blooms (low Secchi depth), but they are made up of a couple of phytoplankton species. Certain species of phytoplankton are preferred food sources for zooplankton (small invertebrates). Generally species like diatoms and green algae can be consumed by the filter-feeding zooplankton, but species like bluegreen algae are low in nutrients and are difficult to consume. Some species like the dinoflagellates can grow horn like points to discourage potential predators. In nutrient rich waters where there is plenty of phosphorous, nitrogen can be limited for biological growth. While most species can't grow due to the lack of nitrogen, bluegreen algae (cyanobacteria) have the ability to utilize nitrogen from the atmosphere when required. This gives bluegreen algae the ability to dominate in many eutrophic lakes.

Soluble Metals Analysis

The soluble metals analysis indicates the exposure of humans and aquatic organisms to toxic metals. These metals often build up as they are consumed through the food chain. Water samples provide an indicator for additional problems. Soluble forms of metal ions are more prevalent in low pH (pH <7, or acidic) environments.

MTBE Analysis

MTBE (methyl tertiary-butyl ether) is a chemical additive to gasoline to improve combustion. Due to its high solubility, MTBE travels and blends into aquatic systems rapidly. While not found to be extremely hazardous at low levels, the offensive smell and taste is detectible by humans at extremely low concentrations. The effect of MTBE on humans and aquatic systems is still under investigation.

Inorganic Analysis

Alkalinity

Alkalinity is measured in terms of mg/L of calcium carbonate. It indicates a lakes ability to buffer incoming acidic pollution and situational changes.

Ammonia

Ammonia is a gas that is toxic to fish and is more visible at a higher pH. Ammonia is created through anthropogenic inputs, bacteria cell respiration, and the decomposition of dead cells. Due to being a gas, given time ammonia will volatilize from the water. At a lower pH, much of the ammonia is converted to ammonium (a nutrient for root bound plant life) and utilizes DO in the nitrification process.

Chloride

The chloride ion is an indicator of any salinity increases within a lake. Most fresh water aquatic species are sensitive to salinity changes.

Nitrate

Nitrate is the nitrogen product created through the nitrification of ammonium. Nitrate is a soluble form of the nutrient nitrogen and is utilized by phytoplankton.

Total Phosphorous

The total phosphorous provides a measure of both utilized and soluble phosphorous within water samples. Phosphorous is a required nutrient for plant growth and development.

Ortho Phosphorous

Ortho phosphorous is the soluble form of phosphorous that is utilized by free-floating aquatic plants (phytoplankton).

Kjeldahl N

Kjeldahl nitrogen or total Kjeldahl nitrogen (TKN) is a measure of the total concentration of nitrogen in a sample. This includes ammonia, ammonium, nitrite, nitrate, nitrogen gas, and nitrogen contained within organisms.

COD

Chemical Oxygen Demand (COD) is a measure of the total oxygen required to complete the chemical and biological demands of a sample.

Fish Tissue Analysis

Fish tissue is analyzed to examine potential exposure of humans to toxicants as well as the health of the aquatic food chain. In aquatic systems toxic contaminants can build up (or bioaccumulate) within animals at the top of the food chain. Contaminants (especially organic pollutants) are retained within the fat tissue of an organism, therefore in fish samples the lipid content is often measured.

Lake Code Designation

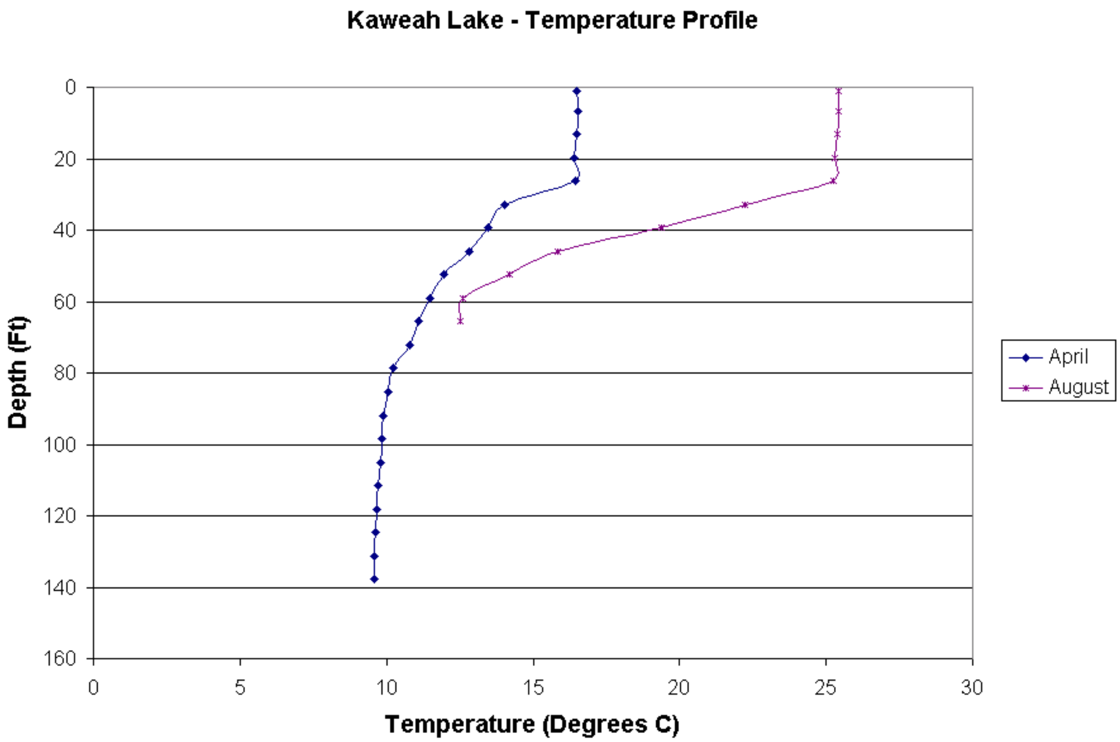
Laboratory Reports are provided in the previous sections.

Sample ID is "XX-YY-ZZ" where

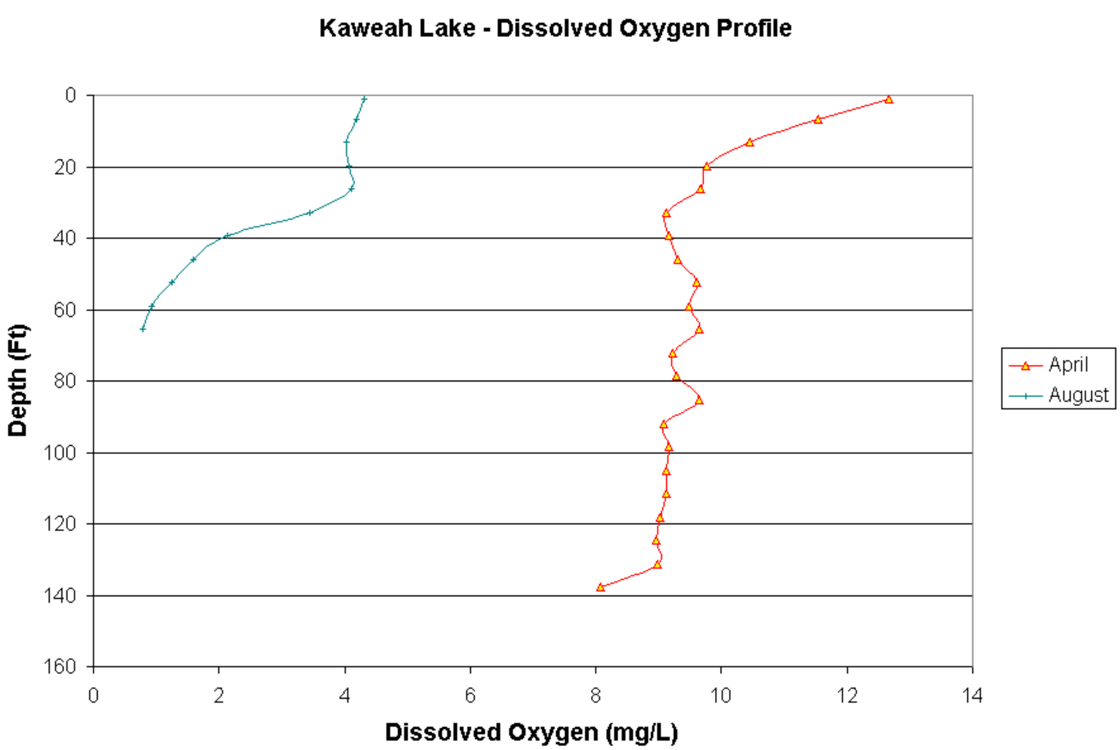
XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summar	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

Example: BB-SU-S is for a water sample taken from Black Butte in the Summer on the Lake's Surface.

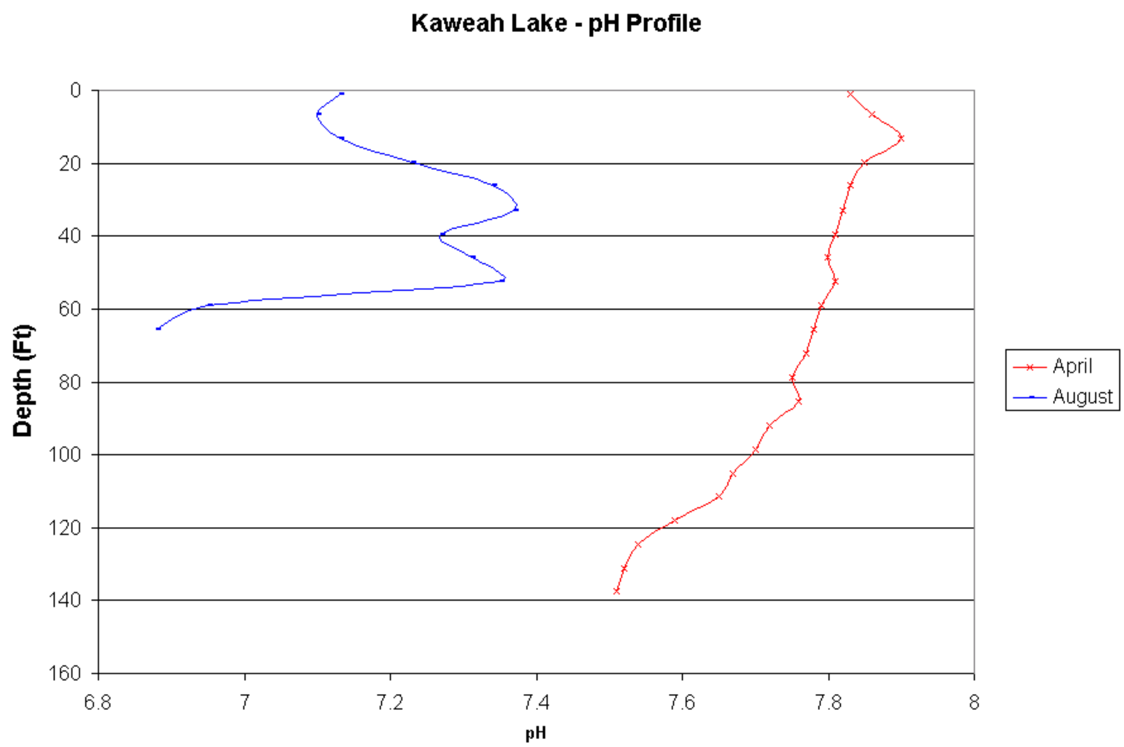
Appendix B: Profile Data and Charts (Secchi Disc, Temperature, DO, and pH)



Kaweah Lake - Temperature Profile
Depth (Ft)
0
20
40
60
80
100
120
140
160
0
5
10
15
20
25
30
Temperature (Degrees C)
April
August



Kaweah Lake - Dissolved Oxygen Profile
Depth (Ft)
0
20
40
60
80
100
120
140
160
0
2
4
6
8
10
12
14
Dissolved Oxygen (mg/L)
April
August

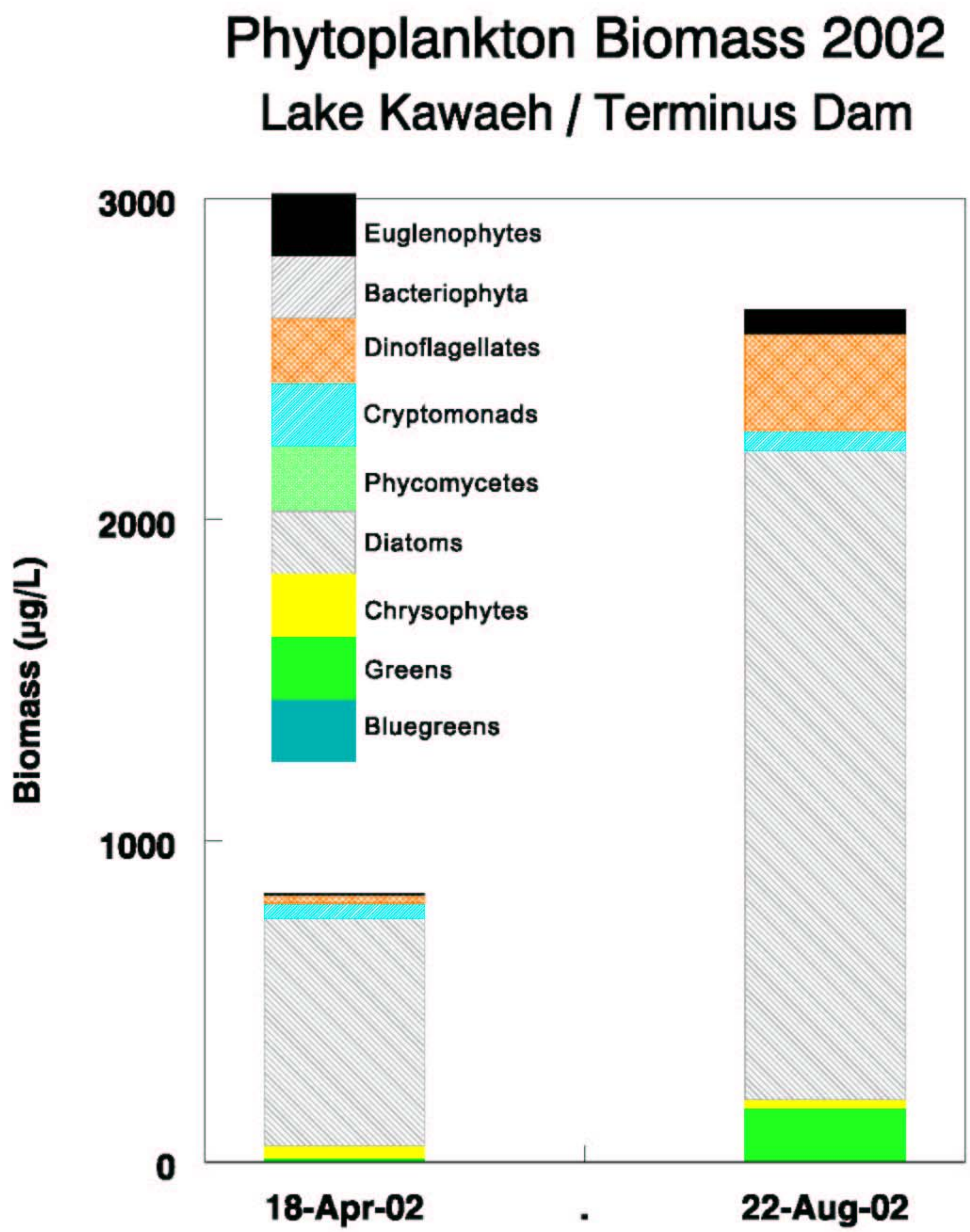


Kaweah Lake - pH Profile
Depth (Ft)
0
20
40
60
80
100
120
140
160
6.8
7
7.2
7.4
7.6
7.8
8
pH
April
August

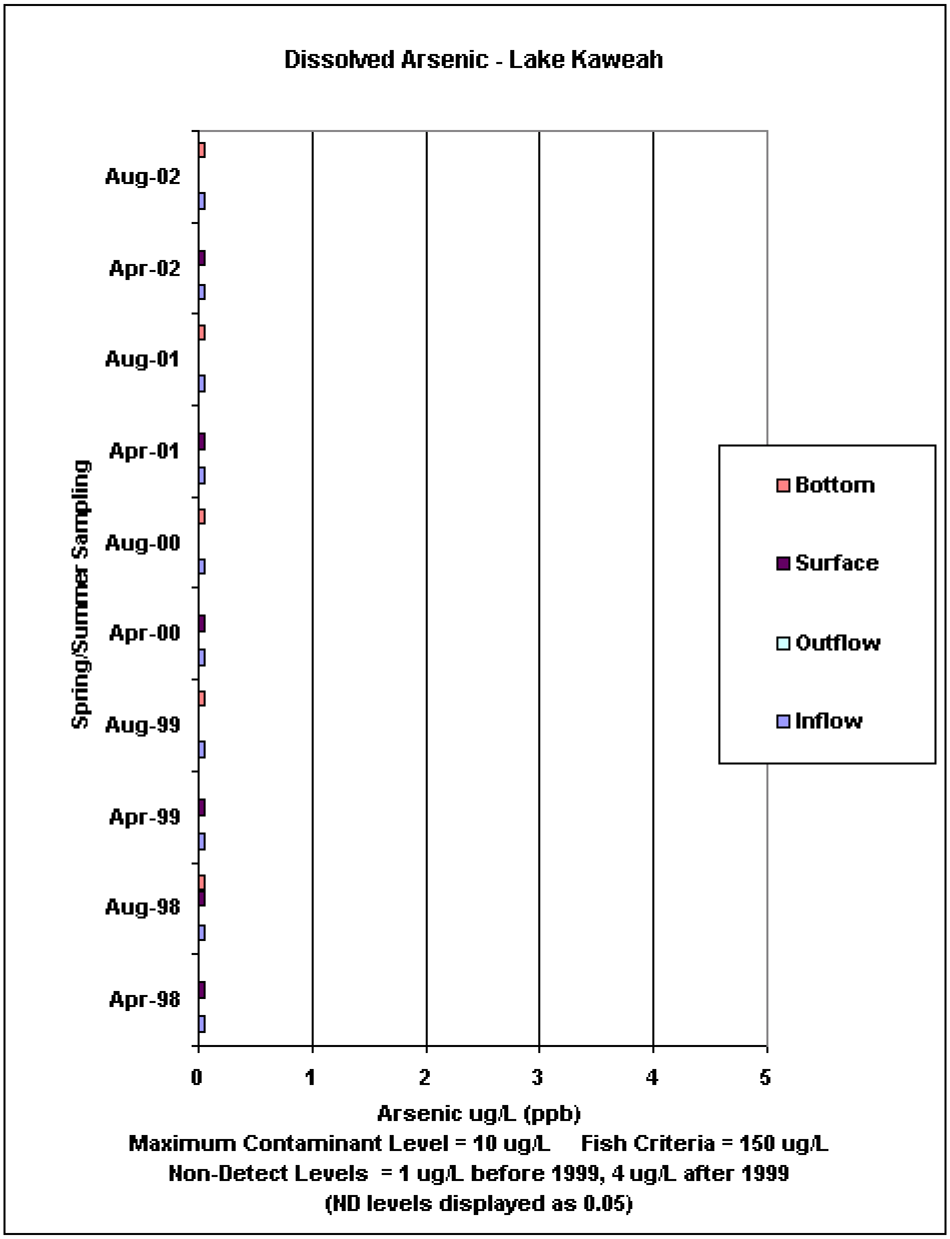
LAKE KAWEAH					
Sample Location: Behind dam				**Date:** 8/22/02	
Observers: Tim McLaughlin				**Time:** 9:40 am	
Lake Elevation: 579.40					
Weather Conditions:					
Wind Speed: 5		**Precipitation:** 0		**Temp (F):** 70	
SECCHI Depth: 5 feet and 9 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
18.8	65.6	12.52	87	0.79	6.88
18	59.1	12.59	82	0.93	6.95
16	52.5	14.21	52	1.24	7.35
14	45.9	15.84	49	1.60	7.31
12	39.4	19.40	55	2.14	7.27
10	32.8	22.25	74	3.45	7.37
8	26.2	25.27	85	4.11	7.34
6	19.7	25.29	85	4.07	7.23
4	13.1	25.37	86	4.03	7.13
2	6.6	25.42	85	4.19	7.10
0.03	1	25.44	85	4.31	7.13
KAWEAH (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
68.8	7.76		-	-	40
VISUAL OBSERVATIONS:					

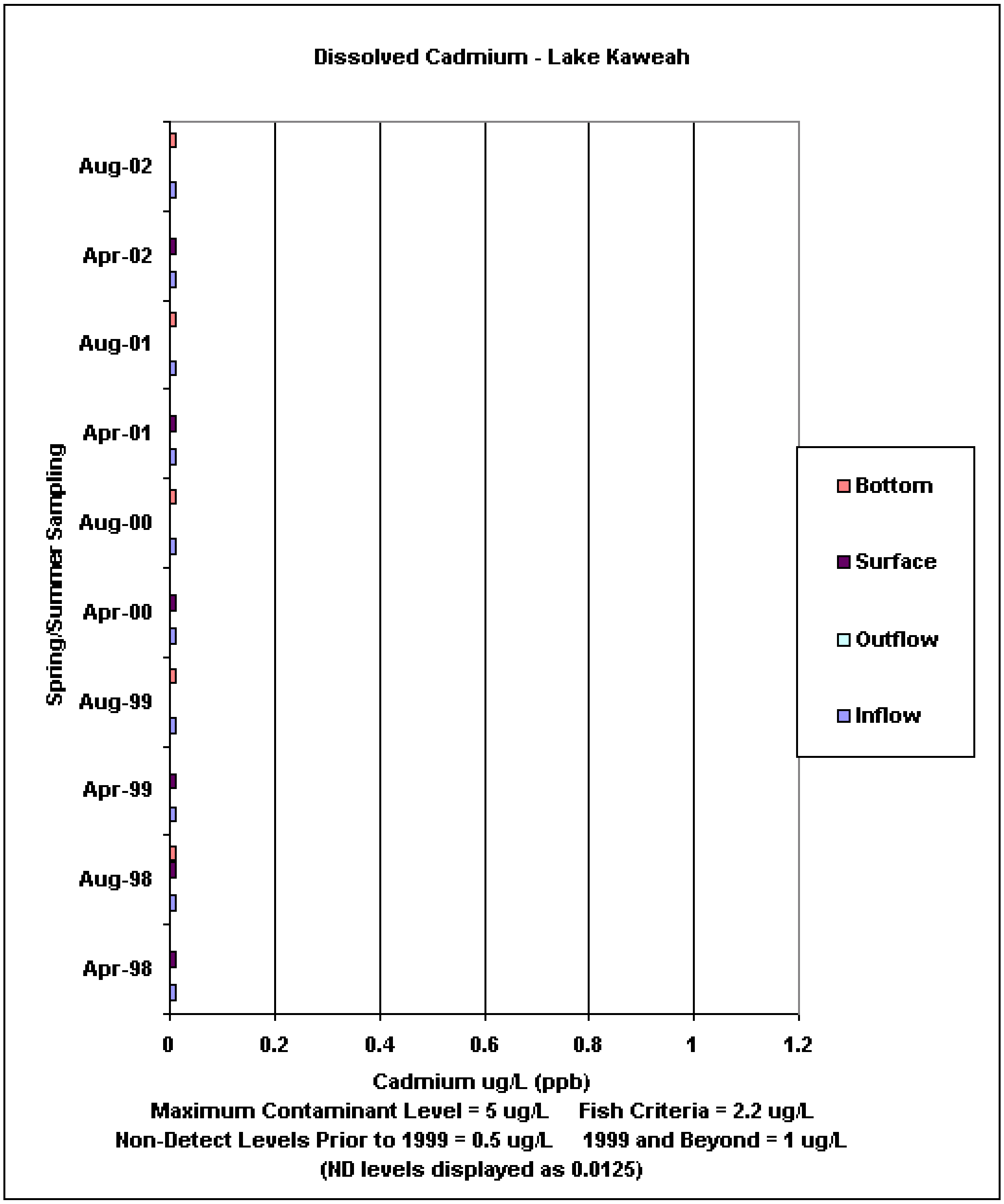
LAKE KAWEAH					
Sample Location: Behind dam				**Date:** 4/18/02	
Observers: Tim McLaughlin				**Time:** 9:45 am	
Lake Elevation: 658.30					
Weather Conditions:					
Wind Speed: 5		**Precipitation:** 0		**Temp (F):** 60	
SECCHI Depth: 10 feet and 10 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
41.4	137.6	9.59	47	8.07	7.51
40	131.2	9.57	47	8.99	7.52
38	124.7	9.61	47	8.97	7.54
36	118.1	9.69	46	9.02	7.59
34	111.5	9.71	46	9.13	7.65
32	105.0	9.80	45	9.12	7.67
30	98.4	9.84	45	9.16	7.70
28	91.9	9.88	45	9.09	7.72
26	85.3	10.05	44	9.65	7.76
24	78.7	10.22	43	9.28	7.75
22	72.2	10.79	38	9.22	7.77
20	65.6	11.08	36	9.65	7.78
18	59.1	11.48	30	9.49	7.79
16	52.5	11.97	29	9.60	7.81
14	45.9	12.81	24	9.30	7.80
12	39.4	13.46	26	9.17	7.81
10	32.8	14.03	33	9.13	7.82
8	26.2	16.46		9.66	7.83
6	19.7	16.42	33	9.76	7.85
4	13.1	16.47	33	10.46	7.90
2	6.6	16.52	33	11.55	7.86
0.03	1	16.49	33	12.67	7.83
KAWEAH (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
61.7	7.52		-	-	1103
VISUAL OBSERVATIONS:					

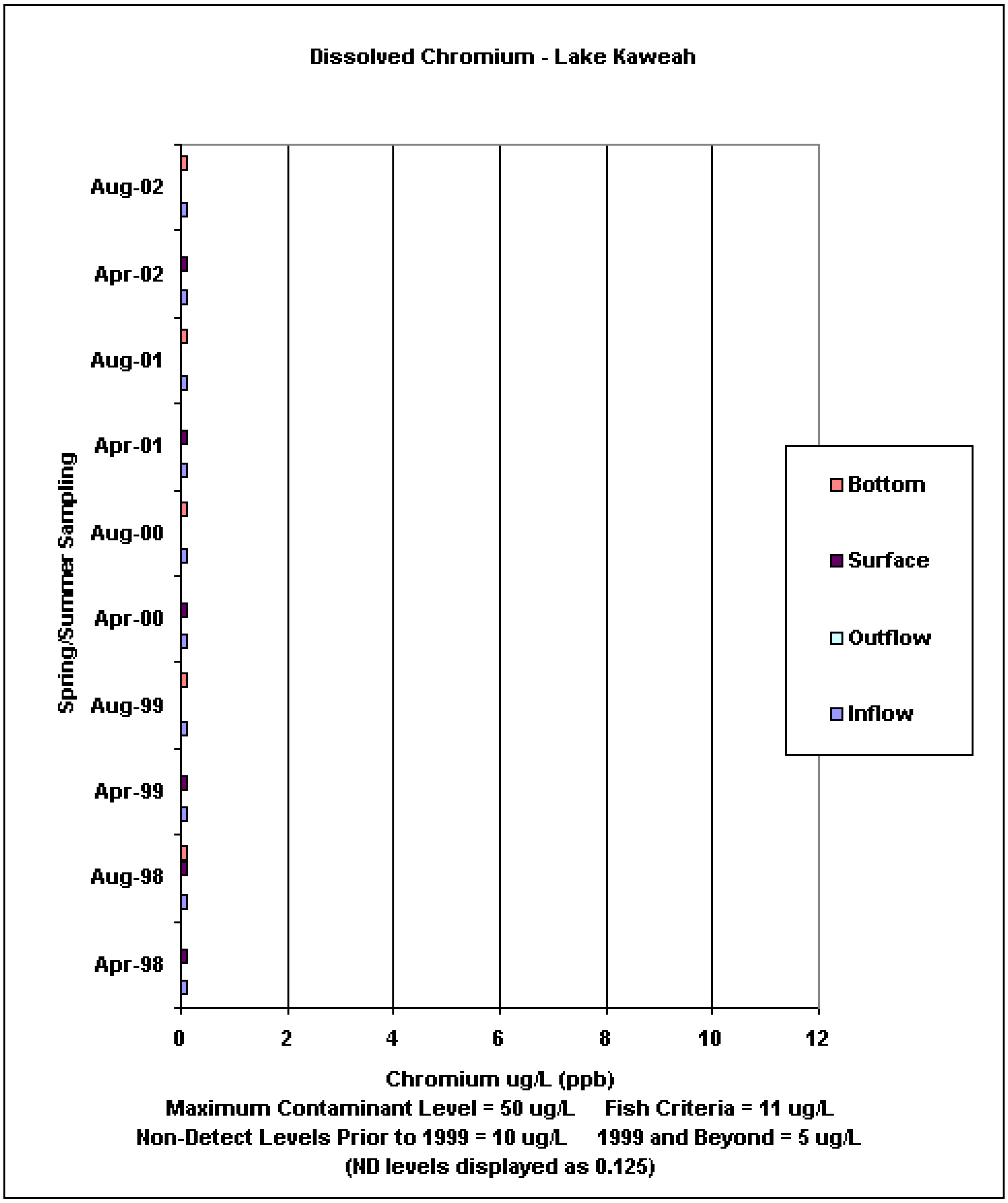
Appendix C: Phytoplankton Data and Charts

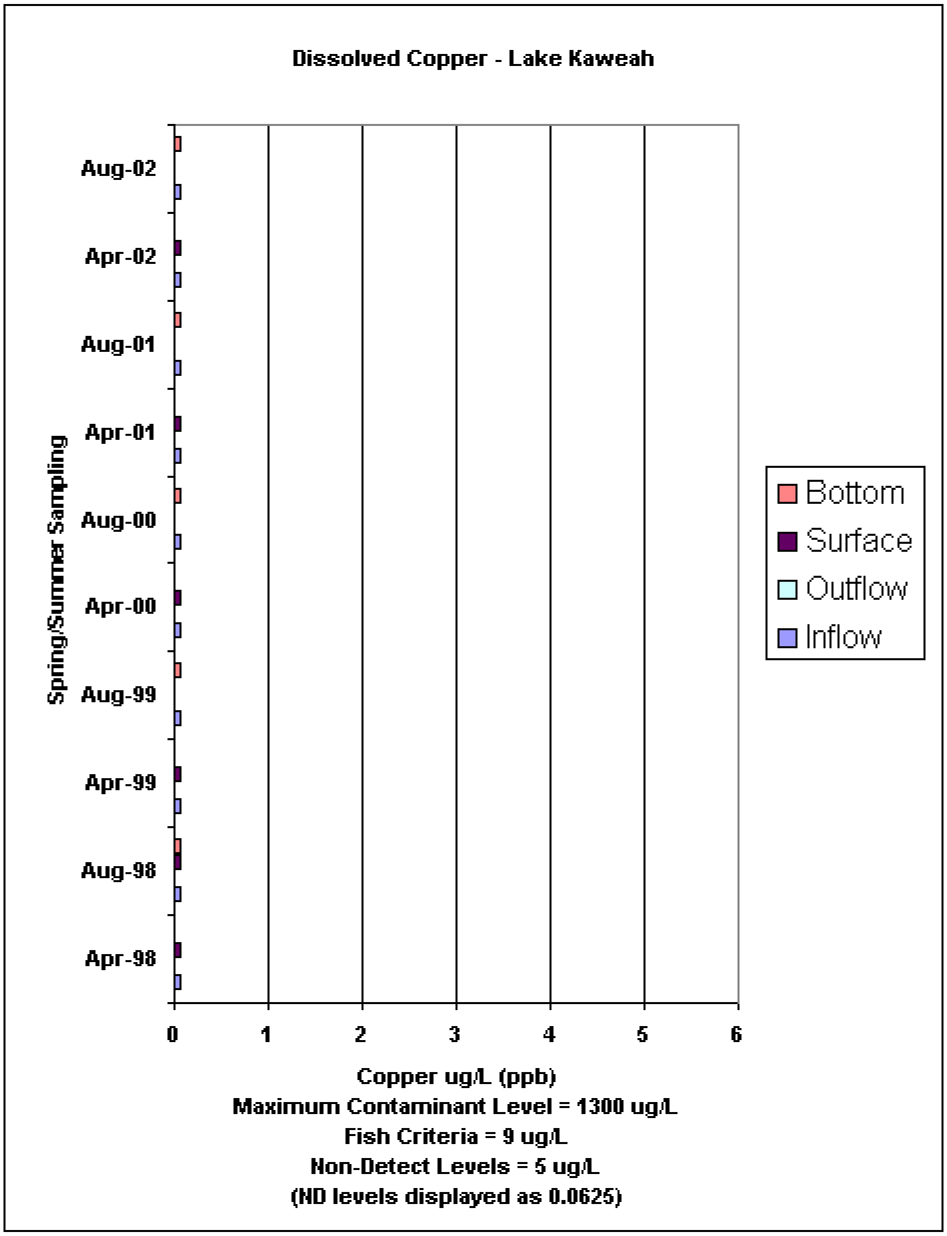

Phytoplankton Biomass 2002
Lake Kawaeh / Terminus Dam
Biomass (µg/L)
3000
2000
1000
0
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
18-Apr-02
22-Aug-02

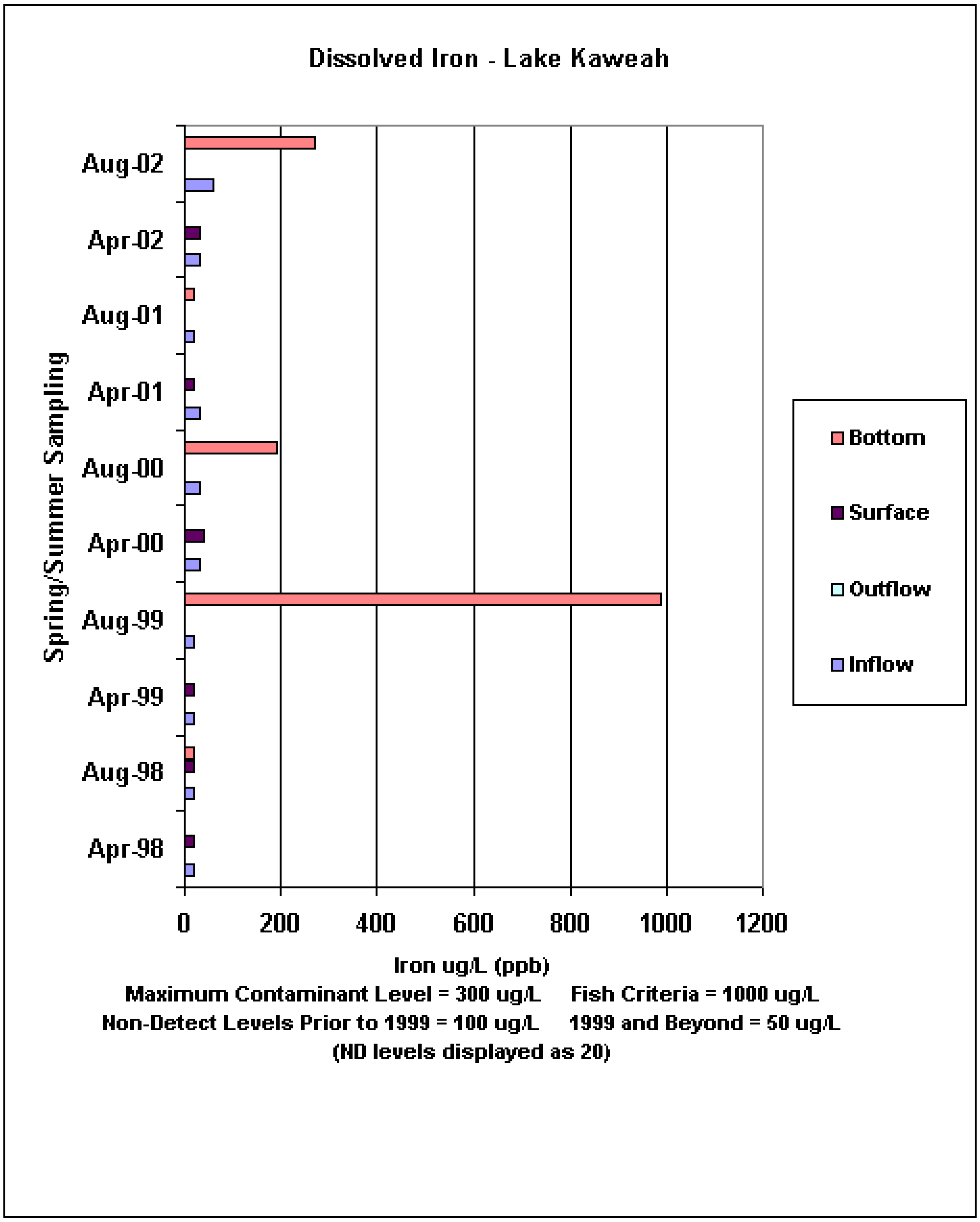
Appendix D: Metals Data and Charts


Dissolved Arsenic - Lake Kaweah
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
5
Bottom
Surface
Outflow
Inflow
Arsenic ug/L (ppb)
Maximum Contaminant Level = 10 ug/L   Fish Criteria = 150 ug/L
Non-Detect Levels = 1 ug/L before 1999, 4 ug/L after 1999
(ND levels displayed as 0.05)

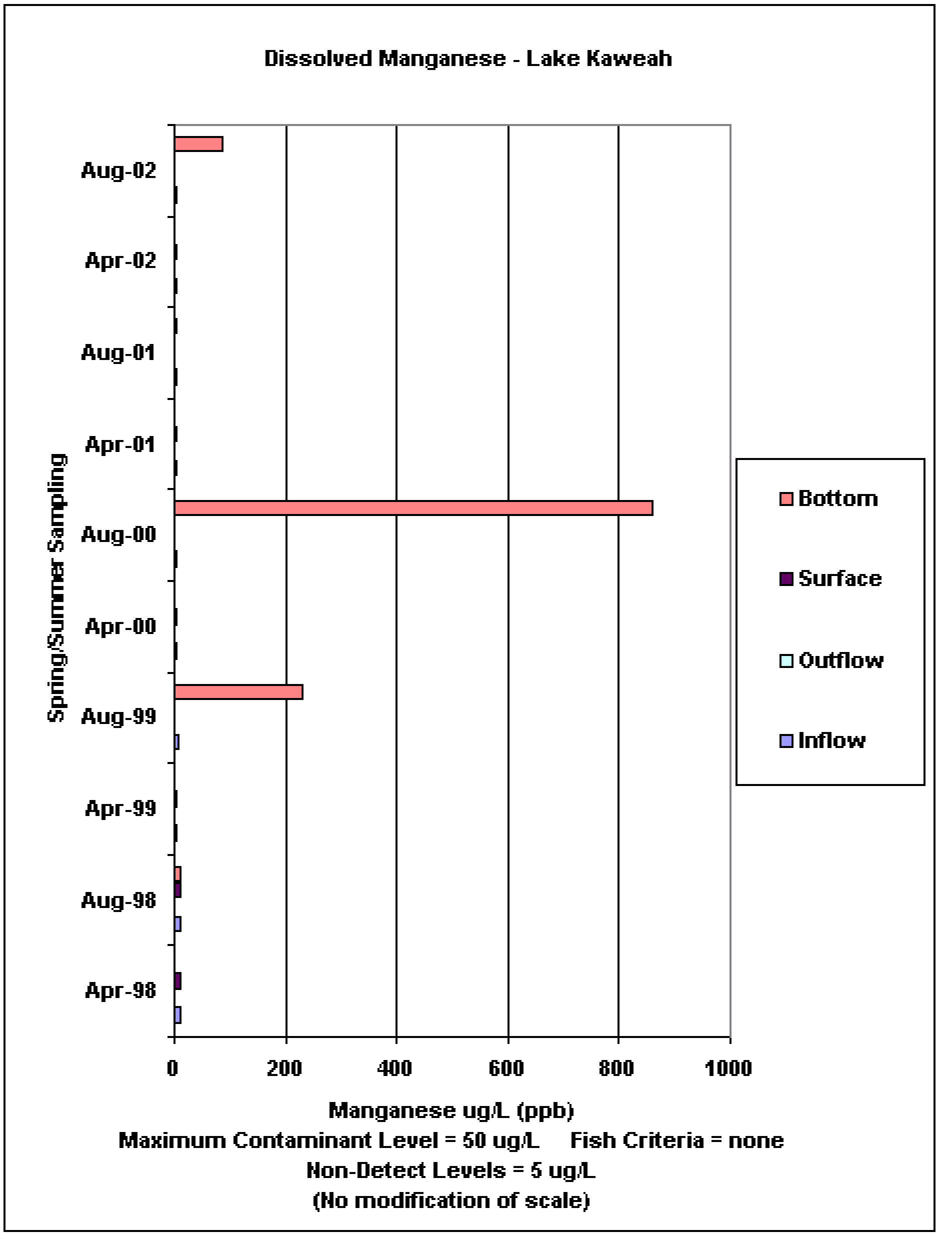

Dissolved Cadmium - Lake Kaweah
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.2
0.4
0.6
0.8
1
1.2
Bottom
Surface
Outflow
Inflow
Cadmium ug/L (ppb)
Maximum Contaminant Level = 5 ug/L Fish Criteria = 2.2 ug/L
Non-Detect Levels Prior to 1999 = 0.5 ug/L 1999 and Beyond = 1 ug/L
(ND levels displayed as 0.0125)

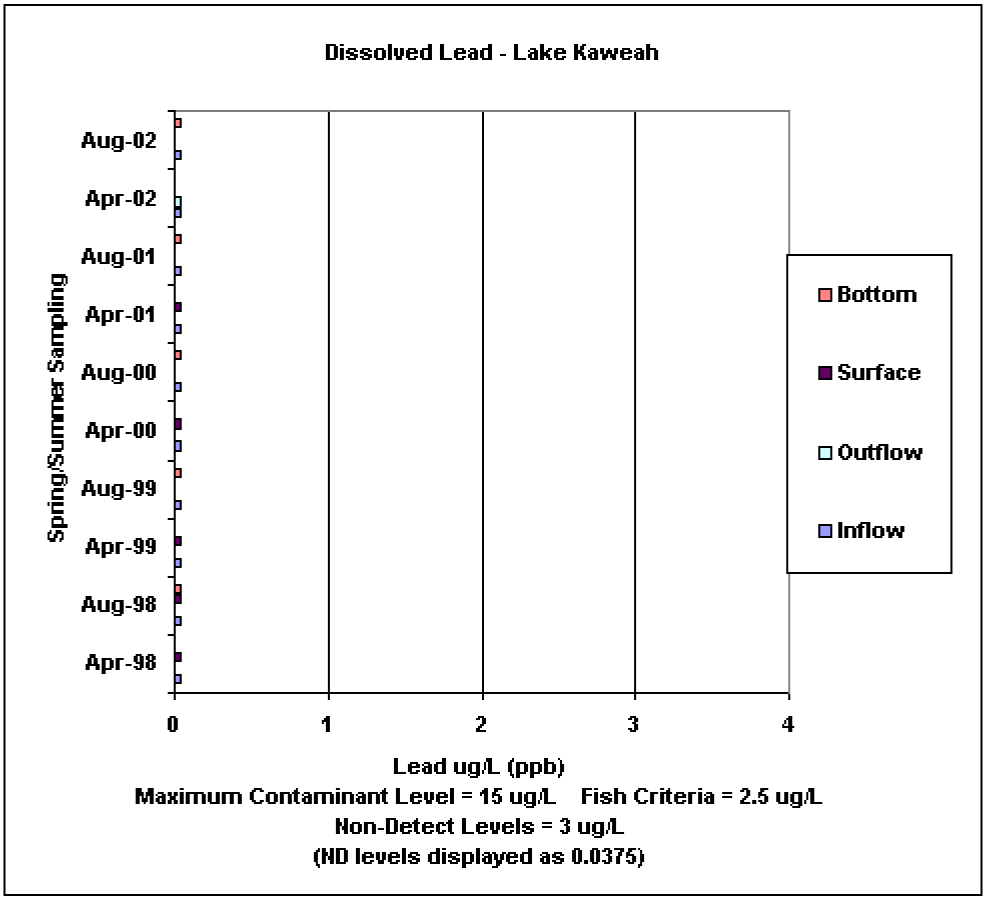

Dissolved Chromium - Lake Kaweah
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
10
12
Bottom
Surface
Outflow
Inflow
Chromium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L 1999 and Beyond = 5 ug/L
(ND levels displayed as 0.125)


Dissolved Copper - Lake Kaweah
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
1
2
3
4
5
6
Copper ug/L (ppb)
Maximum Contaminant Level = 1300 ug/L
Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L
(ND levels displayed as 0.0625)
Bottom
Surface
Outflow
Inflow

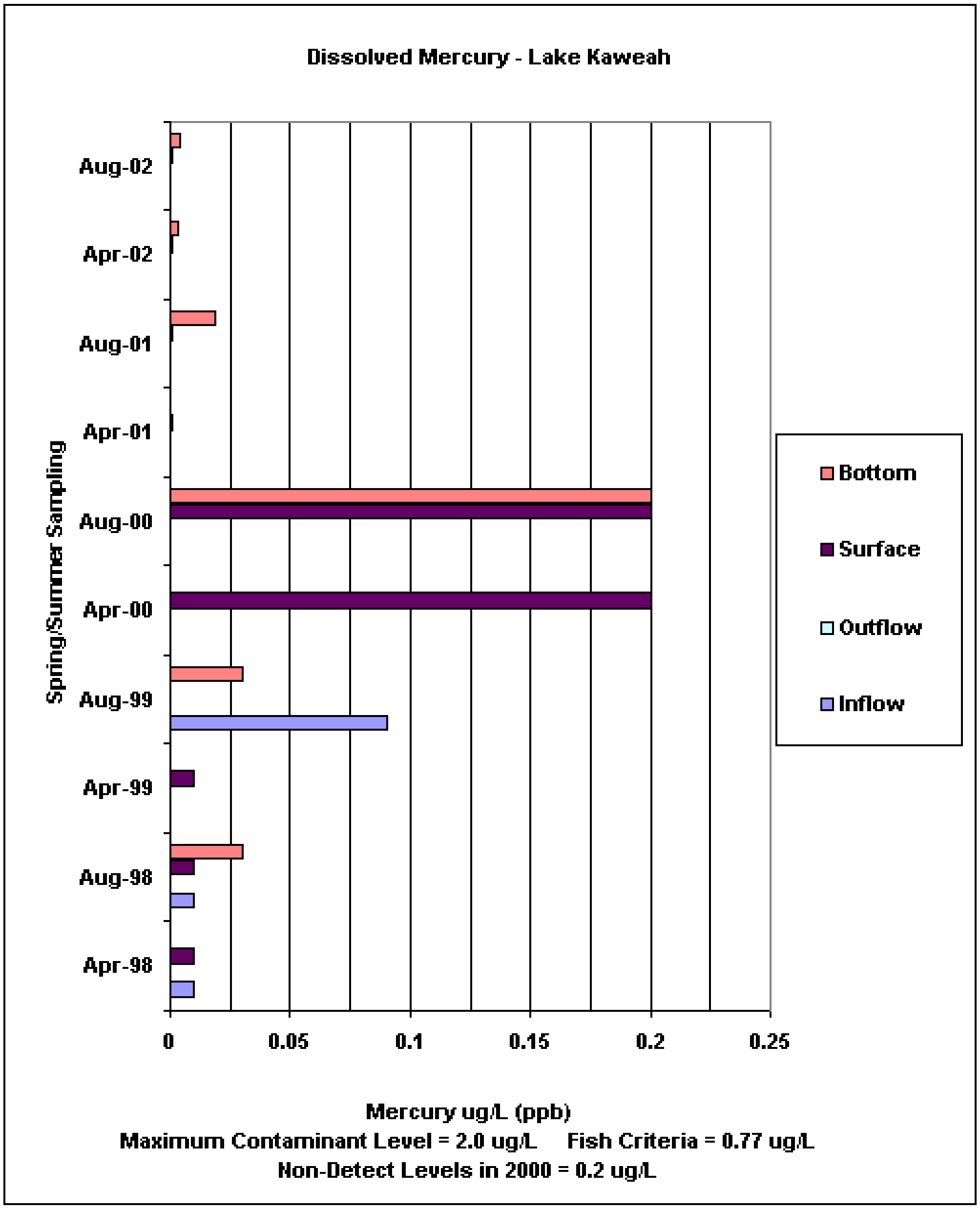


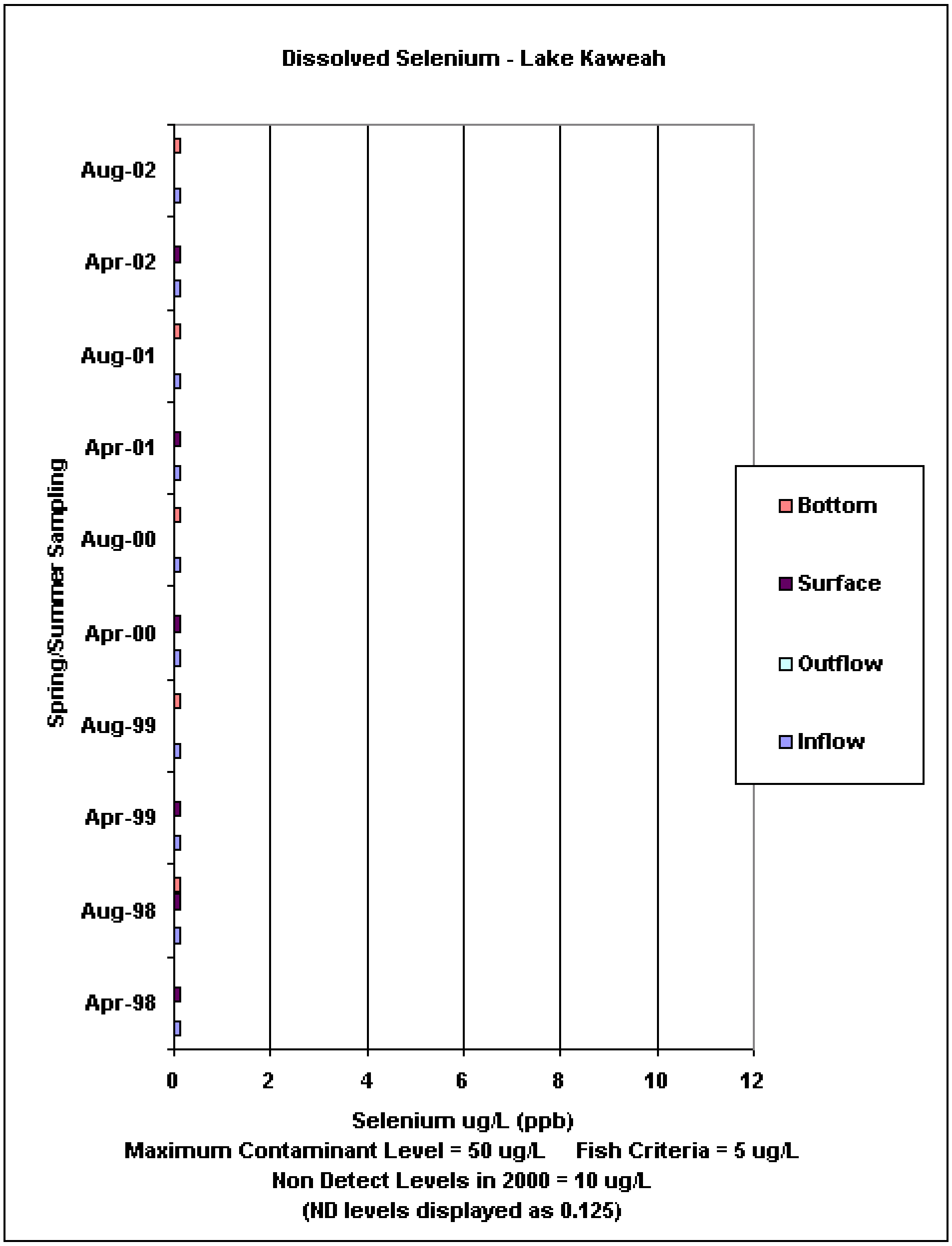
Dissolved Iron - Lake Kaweah
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
200
400
600
800
1000
1200
Bottom
Surface
Outflow
Inflow
Iron ug/L (ppb)
Maximum Contaminant Level = 300 ug/L   Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L   1999 and Beyond = 50 ug/L
(ND levels displayed as 20)

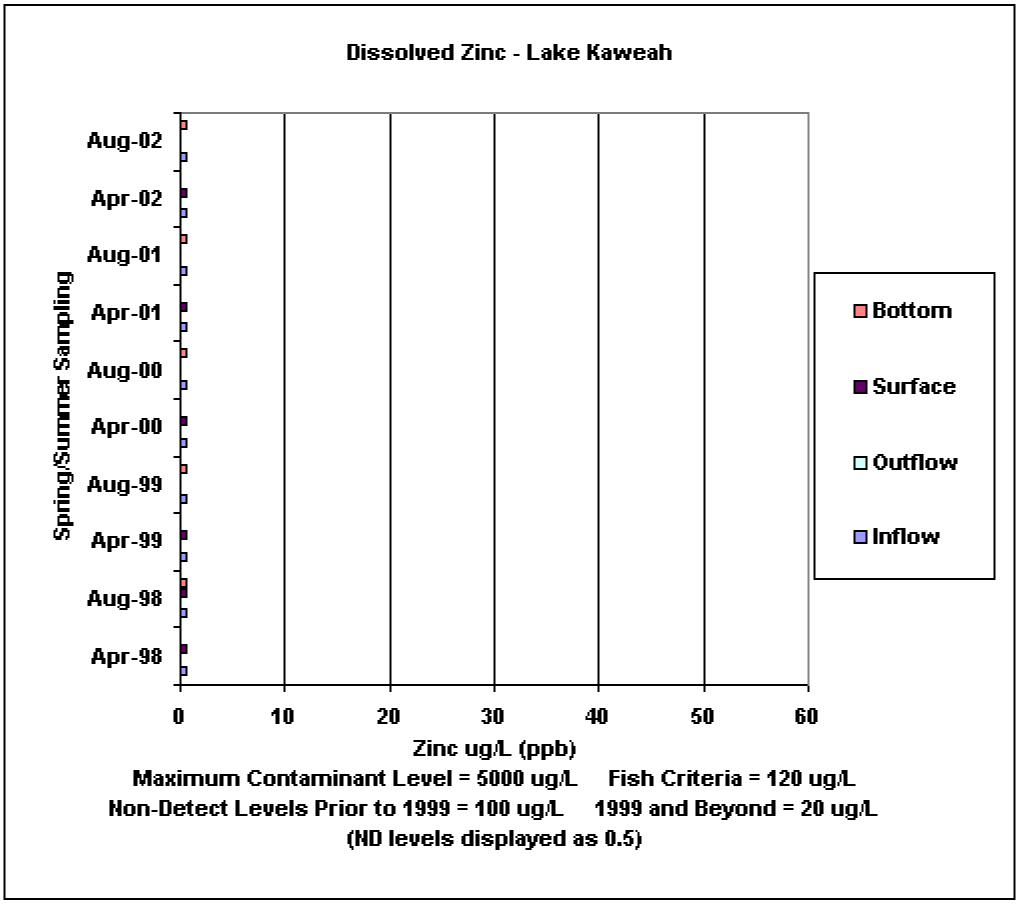

Dissolved Manganese - Lake Kaweah
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
200
400
600
800
1000
Bottom
Surface
Outflow
Inflow
Manganese ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = none
Non-Detect Levels = 5 ug/L
(No modification of scale)



Dissolved Lead - Lake Kaweah
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
Bottom
Surface
Outflow
Inflow
Lead ug/L (ppb)
Maximum Contaminant Level = 15 ug/L Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L
(ND levels displayed as 0.0375)


Dissolved Mercury - Lake Kaweah
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
0.05
0.1
0.15
0.2
0.25
Bottom
Surface
Outflow
Inflow
Mercury ug/L (ppb)
Maximum Contaminant Level = 2.0 ug/L Fish Criteria = 0.77 ug/L
Non-Detect Levels in 2000 = 0.2 ug/L


Dissolved Selenium - Lake Kaweah
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
10
12
Bottom
Surface
Outflow
Inflow
Selenium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = 5 ug/L
Non Detect Levels in 2000 = 10 ug/L
(ND levels displayed as 0.125)



Dissolved Zinc - Lake Kaweah
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
10
20
30
40
50
60
Bottom
Surface
Outflow
Inflow
Zinc ug/L (ppb)
Maximum Contaminant Level = 5000 ug/L
Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L
1999 and Beyond = 20 ug/L
(ND levels displayed as 0.5)

Appendix E: Inorganic Sample Data

Inorganic Results (mg/L) For surface lake waters (spring)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity		60	40	50	60	30	40	70	80	20		100
Ammonia		<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Chloride		21	2	21	4	4	3	<1	6	5		4
Nitrate		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1		<0.1
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Sulfate		5.3	2.6	4.2	8.9	2	1	8.2	9	2.1		4.7
Kjeldahl N		0.6	0.1	0.4	0.2	<0.1	0.3	0.2	0.2	0.2		<0.1
COD					<50							
Tot Solids		120	70	100	110	60	78	100	120	21		150

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	100	70	40	50	20	30	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	13	25	3	21	<1	<1	4	<1	6	4	3	2
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	
Sulfate	18	2.1	2.3	3	2.8	1.9	0.8	8.8	11	1.6	11	3.5
Kjeldahl N	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1
COD	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	170	130	59	110	60	60	90	110	150	30	130	90

Inorganic Results (mg/L) For surface lake waters (summer)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	140	70	40	50	50	40	70	90	80	10	80	110
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
Chloride	16	26	4	19	6	5	5	5	9	3	5	8
Nitrate	<0.1	1.5	<0.1	1.3	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1
Total P	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	16	4.1	3.6	3.5	5.9	2	0.7	7.4	14	1.6	6.4	4.4
Kjeldahl N	<0.1	2.7	<0.1	0.4	0.4	0.3	<0.1	0.2	<0.1	<0.1	0.2	0.6
COD	<50	60	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	200	190	50	120	98	80	80	120	120	52	100	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	90	40		60	40	80	100	130	20	110	180
Ammonia												
Chloride	16	490	5		10	8	3	5	14	4	5	22
Nitrate												
Total P												
Ortho P												
Sulfate	16	4.5	3		9.8	3.2	<0.5	6	14	2.7	5.4	8.7
Kjeldahl N												
COD												
Tot Solids	200	1300	50		140	100	100	150	200	50	140	280

Appendix F: MTBE Table

2002 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2002 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	2		2		<2		<2		
Eastman	5				<2				
Englebright	3		3		10		10	10	
Hensley	3		3		3		3		
Isabella	<2	<2	<2	<2	<2	<2	<2	<2	
Kaweah	2		2	<2	8		6	6	
Martis Cr.	<2				<2				
Mendocino	<2				<2				
New Hogan	<2				3				
Pine Flat	<2		<2		2		2		
Sonoma		3	<2		<2		2		
Success	4		4	4	11	12	11	11	

Notes:

1. Non-Detect is indicated by "<2" since the Reporting Limit is 2 ppb or 0.002 ppm.

2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.

3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.

4. For 2002, the number of MTBE water sampling at each lake is based on last year's lab results.

5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was historically non-detectable. The 2002 results of non-detectable levels were similar except Lake Eastman and New Hogan now reported low, detectable levels of MTBE.

6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because of historically low detectable levels of MTBE.

7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because of historically higher MTBE being found. The 2002 results were similar except Isabella now reported non-detectible levels.

8. In 2001, very high MTBE levels were reported at Lake Isabella during the Spring (18 ug/L near the marina) . During Spring 2000, Lake Isabella reported 21 ug/L. The 2002 results indicate that the previous MTBE problem near the marina was not visible during the Spring 2002 sampling event, and may have been rectified.

G. Fish tissue analysis table

2002 Fish Tissue Results

The following table provides an overview of the lab results for the 2002 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conductng the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The California OEHHA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Mercury Total ppm	FDA Criteria
Black Butte	Sm M Bass	Composite (3)	6/12/02	0.24	0.26	1 ppm
Eastman	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Englebright	Note 5	N/A	N/A	N/A	N/A	
Hensley	Black Bass	Composite (3)	4/23/02	<0.10	0.72	1 ppm
Isabella	Black Bass	Composite (3)	6/4/02	0.20	0.21	1 ppm
Kaweah	Sm M Bass	Composite (3)	7/14/02	0.11	0.53	1 ppm
Martis Cr	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Mendocino	Note 6	N/A	N/A	N/A	N/A	
New Hogan	Lg M Bass	Single (1)	6/3/02	<0.10	0.34	1 ppm
Pine Flat	Note 4	--------------------	-----------	----------	-----------	< Mon 01
Sonoma	Note 6	N/A	N/A	N/A	N/A	
Success	Black Bass	Composite (3)	4/15/02	<0.10	0.18	1 ppm

Notes:

9. Non-Detect is indicated by "<0.02". The lab Detection Limit for mercury is 0.02 ppm.
10. Total Mercury was reported in mg/g or ppm.
11. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.
12. The fish tissue program was terminated at Eastman and Martis Creek in 2001 and in Pine Flat in 2002 due to low total mercury results. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout). For Pine Flat total mercury was 0.21 ppm in 2000 (composite of three Sacramento Sucker fish) and 0.23 in 2001 (composite of three spotted bass).
13. Due to seasonal conditions, a fish could not be successfully collected at Lake Englebright. Another attempt will be accomplished for the 2003 report.

14. Fish were not collected at Mendocino or Sonoma due to communication difficulties.

The above 2002 total mercury results indicate only Hensley is higher than average. However, in 2001, the total mercury results were only 0.30 ppm for Hensley (small mouth bass). The 2003 fish tissue program should provide additional data. EPA fact sheet on fish advisories (EPA-823-F-99-016) indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.

Annual Water Quality Report

LAKE ISABELLA

Water Year 2002

Written by
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Water Quality Engineer
U. S. Army Corps of Engineers
Sacramento District
January 2003

TABLE OF CONTENTS

Lake Isabella

I. Purpose

This report is part of an environmental monitoring program that began at Lake Isabella in April 1974. The monitoring program was implemented to determine the level of water quality in the lake for both recreation and environmental health and to satisfy the Department of Army Engineering Regulation 1110-2-8154, "Water Quality and Environmental Management for Corps Civil Works Projects".

II. Brief Description of Lake Isabella

Lake Isabella is located in south-central California, 33 miles northeast of Bakersfield. The lake is nestled in the Sierra Nevada foothills and is surrounded by grasslands and blue oaks. The lake is composed of two branches, one with a length of 8 miles and the other with a length of 9 miles. At maximum capacity, the lake has 11,400 surface acres and holds 570,000 acre-feet of water. The lake was created by the construction of Isabella Dam on the Kern River. The dam is 185 feet high above the streambed at the highest point. Since being built by the US Army Corps of Engineers for flood control and irrigation, the lake has become a popular destination for recreation. Summers are warm and the winters mild, allowing for year-round activities.

Water quality monitoring by the United States Army Corps of Engineers (USACE) began at Lake Isabella in April 1974. Generally there are two sample events a year, spring (April) and late summer (August). Since the start of the monitoring program, a water quality report is produced yearly to list results and address any concerns of the previous water year.

Generally Lake Isabella has a depth of less than 100 feet during the sampling events and is considered a mesotrophic lake when characterized by its clarity. A mesotrophic lake is one that has qualities between an oligotrophic (clear and nutrient limited, example Lake Tahoe) and a eutrophic lake (low clarity and high in nutrients, example Clear Lake). Unlike many of the eutrophic lakes that are monitored by the USACE, Lake Isabella can maintain aerobic conditions (available dissolved oxygen, DO) at the bottom depths during warm late summer months. Similar to many eutrophic lakes, Lake Isabella is warm (>20ºC) in the late summer. Due to the high late summer temperatures, only warmwater fish species could reliably survive in the lake year round. Warmwater fish species include bass, carp, perch, bluegill, crappie, and catfish. Although clearer than eutrophic (nutrient rich) lakes, mesotrophic lakes also can have low water clarity due to algal blooms. Being relatively shallow, the clarity of the lake is subject to being diminished by sediments suspended by wind action. Water clarity is often measured in terms of Secchi Disc depth or SD (Appendix A). Historically, the water clarity in Lake Isabella is good with only ~14.3 % of the samples not meeting the recreational goal of 4 feet or greater (Figure 1). In 2001 the Spring SD measure was 4.08 feet and the late summer sample SD value was better at 5.92 feet.

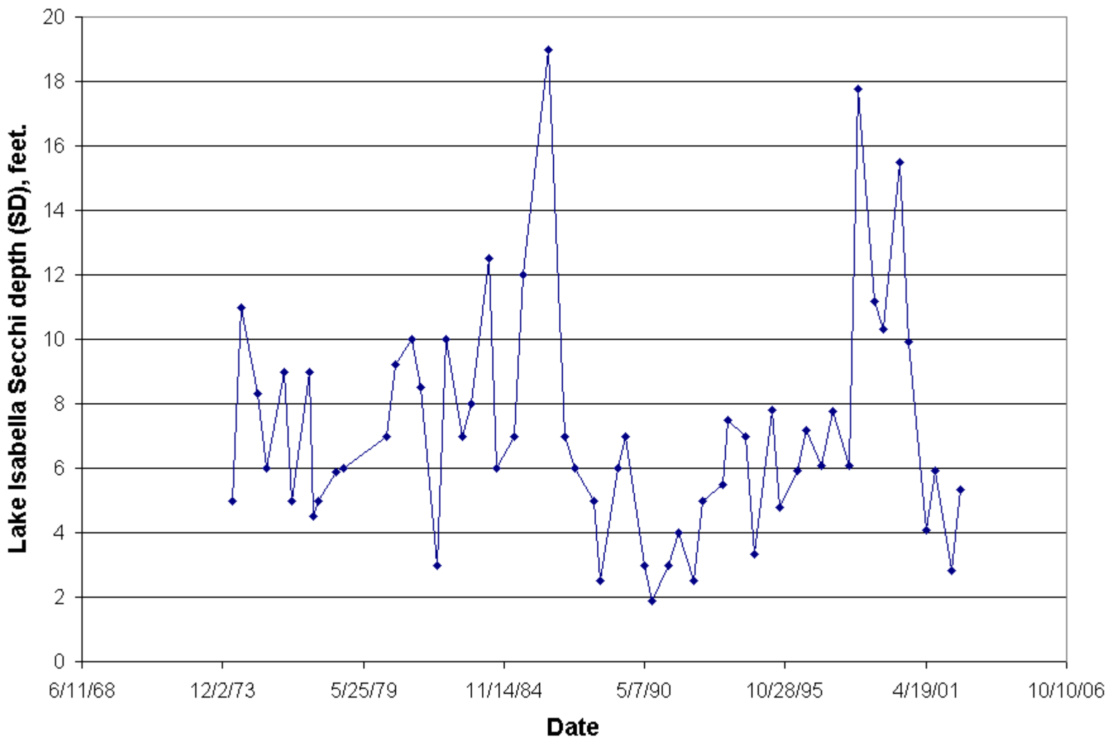

Figure 1. Historical Secchi Depth Values at Lake Isabella (2002 values included).

The 2001 Water Quality Report listed several contaminants of concern at Lake Isabella. The contaminants of concern included MTBE and some dissolved metals (selenium, manganese, and mercury). These contaminants are examined in this 2002 water quality report.

III. Sample Summaries for this year.

Introduction

The following general summaries are split into their respective sample types. Each type of sample summary includes a discussion of both the spring (April) and late summer

(August) samples to better examine trends within the current year. The types of parameters monitored this year include: Secchi Disc depths, water column profiles (temperature, DO and pH), phytoplankton characterization, metals concentrations, MTBE concentrations, Inorganic characterization (alkalinity, phosphorous, nitrogen, etc..), and fish mercury concentrations. For a more detailed explanation of the importance for each type of sample, please see Appendix A.

SECCHI DEPTH

The Secchi Disc depths found during the spring and late summer sampling were lower than the historical average (historical mean SD = 7.1 feet). More often the clarity is better in the late summer than in the late spring, but not always. In spring 2002 the water clarity was low and the SD was 2.83 feet, which was worse than the previous year (2001 Spring SD = 4.08 feet) and less than the recreational goal of 4 feet. The late summer SD of 5.33 feet was above the recreational goal of 4 feet and but was less than the previous year (Summer 2001 SD = 5.92) (Appendix B).

TEMPERATURE VALUES

The temperature profiles for Lake Isabella are indicative of a seasonally well-mixed shallow lake. The lake is semi stratified in the spring, but is mixed by the warm temperatures of late summer. The difference in the depth of the lake between the spring and late summer sampling events was relatively small (spring depth = 91.9 feet, late summer depth= 78.7 feet), but the average temperatures were very different (spring average temp. = 13.1 ºC, late summer average temp.= 22.1 ºC). Lake Isabella's temperature increases in late summer due to not having a deep-water area to buffer it from the warm summer air temperatures. Due to the warmth of the water, coldwater fish species would find it difficult to breed and survive year round. For detailed results obtained during the sampling events, please see Appendix B.

DISSOLVED OXYGEN

The dissolved oxygen (DO) concentration differs greatly from spring to late summer. In the spring DO concentrations are 10.10 mg/L near the surface and low 5.61 mg/L at the bottom of the lake. DO concentrations near the surface are near saturation, which is 10.29 mg/L at 14 ºC. DO concentrations in the late summer are much lower and nearly constant from near the surface (DO = 3.76 mg/l) to near the bottom of the lake where it decreases (DO =3.41 mg/l). The lower DO values at the bottom of the lake are associated the decomposition of waste materials. Fish species that require greater than 5 mg/l DO and cooler water temperatures (< 20ºC) would be unlikely to thrive year round in Lake Isabella. For detailed results obtained during the sampling events, please see Appendix B.

PH LEVELS

In the spring sample event, pH values in the lake were slightly basic (pH = ~7.7) throughout the water column. The pH values in the late summer profile varied widely. The pH was slightly basic towards the middle waters (max pH = 7.47) and nearly neutral at the top and bottom (pH near surface = 7.03, pH bottom = 7.15). The lower pH values at the top and bottom of the lake increase the likelihood that higher soluble metal concentrations will be in those areas. For detailed results obtained during the sampling events, please see Appendix B.

PHYTOPLANKTON

In the spring sample event the algal biomass within the lake was low (Biomass = 1380.33 μg/L) compared to spring 2001 (2001 Spring biomass = 3521.53 μg/L). In spring 2001 and 2002 diatoms were the most dominant species. In late summer the same trend occurred and the phytoplankton population was much higher in summer 2001 (2001 Summer Biomass = 808.49 ug/L) than summer 2002 (Biomass = 438.69 ug/L). Diatoms were the most dominant species during the 2002 late summer sampling events, but blue-green algae dominated in summer 2001. Interestingly, no blue-green were found in the late summer 2002 water sample. Although the water clarity during the late summer sampling event was lower in 2002 compared to 2001, the algal species seen in 2002 can be better utilized by in the aquatic food chain. While most phytoplankton species must obtain nitrogen (a required nutrient for growth) from aqueous forms in the lake, blue-green algae have the ability to use the atmospheric nitrogen gas (by nitrogen fixation). In lakes that are limited in nitrogen availability, nitrogen fixing is a distinct advantage. Blue-green algae is often thought of as a nuisance due to the inability of it to be used in the aquatic food chain and for its impact on water clarity. For detailed results obtained during the 2002 sampling events, please see Appendix C.

METALS

Only one of the dissolved heavy metal samples exceeded any criteria during either the 2002 spring and summer sampling events.

In one spring lake influent sample the concentration of manganese (Spring Mn influent = 65 ppb) was higher than the secondary MCL (Mn MCL = 50 ppb). The secondary manganese MCL is not based on toxic effects, but rather to minimize the objectionable qualities manganese for human usage (laundry stains and taste). Contaminants will continue to be monitored in the coming year for any changes. For detailed results obtained during the sampling events, please see Appendix D.

MTBE

Concentrations for MTBE around the lake were found to be below the detection limit (< 2 ppb) during both spring and late summer sampling events. For detailed results obtained during the sampling events, please see Appendix F.

INORGANIC ANALYSIS

The spring and summer sample results were within expected ranges and levels. The only result to note was the low alkalinity value (Alkalinity inlet = 20 mg/L $CaCO_3$) associated with waters flowing into the lake during spring 2002. The spring 2002 inlet sample alkalinity was the lowest of all of the lakes monitored by the USACE [another granitic watershed?]. For detailed results obtained during the 2002 sampling events, please see Appendix E.

FISH TISSUE ANALYSIS

Fish tissue analysis for total mercury was performed on a composite sample composed of tissue from three black bass collected in June 2002. The composite sample had a resulting total mercury concentration of 0.21 ppm. This is below the California Office of Environmental Health Hazard Assessment action level to continue fish monitoring (0.3 ppm) and well below the U.S. F.D.A. criteria for a fish advisory (1 ppm). For detailed results obtained during the sampling events, please see Appendix G.

IV. Conclusions

Lake Isabella is a relatively shallow mesotrophic lake that can support warmwater fish species. Coldwater fish that require temperatures below 20°C and dissolved oxygen concentrations greater than 5 mg/L would have difficulties surviving the summer conditions at Lake Isabella. Water clarity in Lake Isabella during the 2002 sampling events was lower than average and below the recreational goal of 4 feet during the spring.

In the 2002 Lake Isabella sampling events only dissolved manganese exceeded a secondary water quality limit based on aesthetics. Manganese concentrations were above the secondary MCL for drinking water in one lake influent sample during the spring. Since the MCL for manganese isn't based on toxic effects, but rather on objectionable qualities, it isn't considered a contaminant of concern. Although the 2001 water quality report listed several contaminants of concern they were not apparent this year. Nonetheless levels in Lake Isabella will continue to be monitored in the event that this year's values are anomalous.

Fish tissue mercury concentrations in fish composite samples were below the California OEHHA's screening level for a second consecutive year (<.3 ppm) nonetheless mercury in fish tissue will be monitored for another year to see if there are variations that take concentrations above this level.

V. References

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VI. Appendices

Appendix A: Glossary of Sample Types

Glossary of Sample Types

This glossary of sample types is intended to provide a general background and indicate the importance of each sample in determining water quality. These are meant to be brief and basic. If a further explanation is desired please refer to the list of references provided in this report.

Secchi Depth

One of the oldest and easiest methods to determine lake clarity is the Secchi depth (SD). The Secchi depth is determined by dropping a Secchi disc into a water body and determining the depth that it is last visible from the surface of the water. Secchi discs are generally white and 20 cm in diameter. Secchi depth values are most impacted by the light intensity at the time of sampling and the scattering of light by solid particulates within the water column. Algal growth (phytoplankton) and sediment re-suspension are often major constituents of solid particulates within the water column. Secchi depth values can be used to estimate the Trophic state or the nutrient levels within the lake. The more nutrients are available, the larger likelihood of algal blooms that limit water clarity. Due to recreational concerns for safety, the goal for Secchi depth values is four feet or greater.

Temperature Profiles and Data Points

The temperature profile of a lake provides information how a lake is operating and the potential for aquatic biota to live within the lake. The temperature profile is a direct indicator if a lake is stratified. Stratification in lakes is created generally by temperature affecting the density of water molecules. Stratification is usually indicated by a region of similar temperature nearer the surface of the water (epilimnion), then a region of temperature transition (metalimnion), to another layer of nearly constant temperature at the bottom of the lake (hypolimnion). Each layer in a stratified lake is important, but the existence of a hypolimnion can drastically impact how well a lake can handle warmer temperatures such as those found in northern California during the summer. The hypolimnion acts as a buffer against large temperature shifts. The nature of dam operation is that water is discharged near the bottom, releasing the hypolimnion, and eliminating stratification. This operation limits the ability of reservoirs to regulate their temperature during the summer months. Stratification isn't always desirable. When a lake isn't stratified and is instead well mixed, the required nutrients near the bottom of the lake become available to phytoplankton for growth. Temperatures within lakes also indicate which species of fish will survive within a lake. Coldwater species of fish require temperatures below 20 degrees C in order to spawn and survive. If a lake is often above 20 degrees C, then only warmwater fish species will survive.

Dissolved Oxygen (DO) Concentration Profiles

DO is required by organisms for respiration and for chemical reactions within lake waters. The recommended level for DO for most aquatic species survival is 5mg/L. In lakes, biota waste (detritus) falls to the bottom of the lake to be utilized by bacteria. The bacteria need oxygen and will deplete levels near the bottom of a lake, especially during

warm temperature, high respiration conditions. For nutrient rich (eutrophic) lakes more organisms will grow, create wastes, and cause oxygen depleted regions at the lowest areas. Under these conditions only aquatic species that can survive low DO conditions in warm water near the surface will survive.

PH Profiles

The pH profiles of the lakes indicate the potential for certain chemical reactions to occur. In high pH (greater than pH = 7 or basic) aquatic systems, metal pollutants tend to form into insoluble compounds that fall onto the lake floor. In low pH (less than pH = 7 or acidic) systems or areas metal ions become soluble and available for uptake into aquatic organisms. Other compounds like ammonia that are introduced into a low pH aquatic environment will transform into soluble nitrate and be utilized by organisms.

Phytoplankton Analysis

Phytoplankton analysis indicates the health, nutrients, and biodiversity within a lake. Lakes that have few nutrients available (Oligotrophic) will generally have a much lower quantity of phytoplankton (high Secchi depth) but the number of phytoplankton species seen will be large. In a lake that is nutrient rich (eutrophic) there are generally large phytoplankton blooms (low Secchi depth), but they are made up of a couple of phytoplankton species. Certain species of phytoplankton are preferred food sources for zooplankton (small invertebrates). Generally species like diatoms and green algae can be consumed by the filter-feeding zooplankton, but species like bluegreen algae are low in nutrients and are difficult to consume. Some species like the dinoflagellates can grow horn like points to discourage potential predators. In nutrient rich waters where there is plenty of phosphorous, nitrogen can be limited for biological growth. While most species can't grow due to the lack of nitrogen, bluegreen algae (cyanobacteria) have the ability to utilize nitrogen from the atmosphere when required. This gives bluegreen algae the ability to dominate in many eutrophic lakes.

Soluble Metals Analysis

The soluble metals analysis indicates the exposure of humans and aquatic organisms to toxic metals. These metals often build up as they are consumed through the food chain. Water samples provide an indicator for additional problems. Soluble forms of metal ions are more prevalent in low pH (pH <7, or acidic) environments.

MTBE Analysis

MTBE (methyl tertiary-butyl ether) is a chemical additive to gasoline to improve combustion. Due to its high solubility, MTBE travels and blends into aquatic systems rapidly. While not found to be extremely hazardous at low levels, the offensive smell and taste is detectible by humans at extremely low concentrations. The effect of MTBE on humans and aquatic systems is still under investigation.

Inorganic Analysis

Alkalinity

Alkalinity is measured in terms of mg/L of calcium carbonate. It indicates a lakes ability to buffer incoming acidic pollution and situational changes.

Ammonia

Ammonia is a gas that is toxic to fish and is more visible at a higher pH. Ammonia is created through anthropogenic inputs, bacteria cell respiration, and the decomposition of dead cells. Due to being a gas, given time ammonia will volatilize from the water. At a lower pH, much of the ammonia is converted to ammonium (a nutrient for root bound plant life) and utilizes DO in the nitrification process.

Chloride

The chloride ion is an indicator of any salinity increases within a lake. Most fresh water aquatic species are sensitive to salinity changes.

Nitrate

Nitrate is the nitrogen product created through the nitrification of ammonium. Nitrate is a soluble form of the nutrient nitrogen and is utilized by phytoplankton.

Total Phosphorous

The total phosphorous provides a measure of both utilized and soluble phosphorous within water samples. Phosphorous is a required nutrient for plant growth and development.

Ortho Phosphorous

Ortho phosphorous is the soluble form of phosphorous that is utilized by free-floating aquatic plants (phytoplankton).

Kjeldahl N

Kjeldahl nitrogen or total Kjeldahl nitrogen (TKN) is a measure of the total concentration of nitrogen in a sample. This includes ammonia, ammonium, nitrite, nitrate, nitrogen gas, and nitrogen contained within organisms.

COD

Chemical Oxygen Demand (COD) is a measure of the total oxygen required to complete the chemical and biological demands of a sample.

Fish Tissue Analysis

Fish tissue is analyzed to examine potential exposure of humans to toxicants as well as the health of the aquatic food chain. In aquatic systems toxic contaminants can build up (or bioaccumulate) within animals at the top of the food chain. Contaminants (especially organic pollutants) are retained within the fat tissue of an organism, therefore in fish samples the lipid content is often measured.

Lake Code Designation

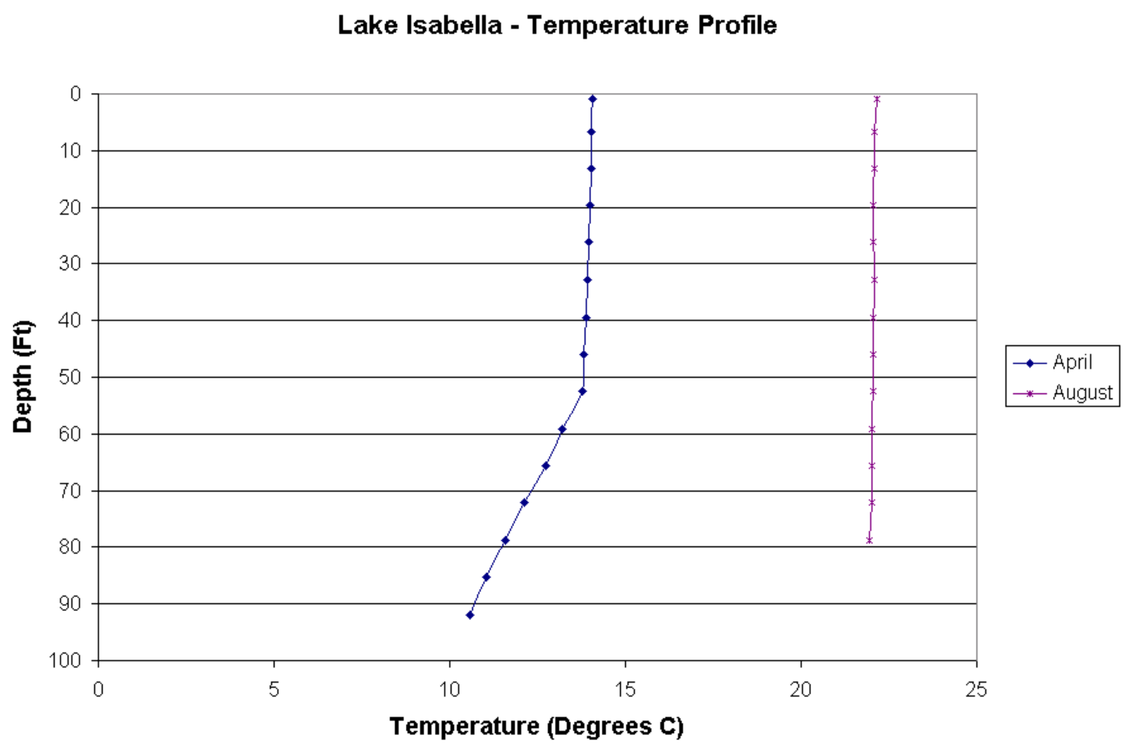
Laboratory Reports are provided in the previous sections.

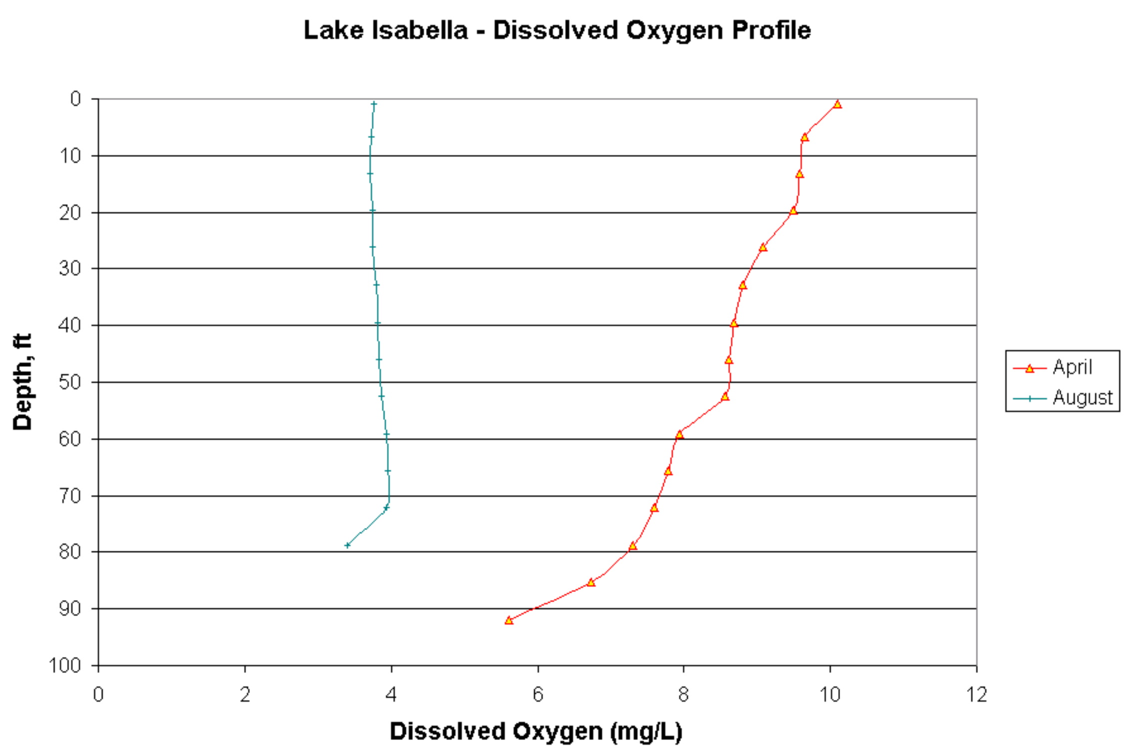
Sample ID is "XX-YY-ZZ" where

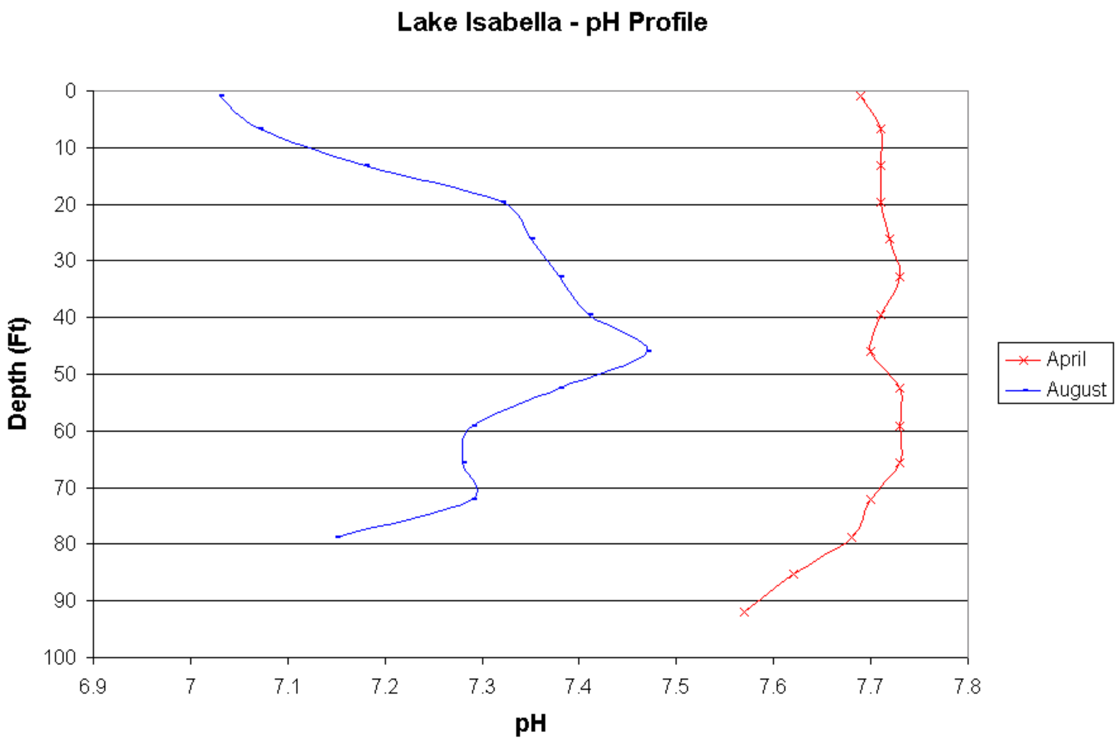
XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summar	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

Example: BB-SU-S is for a water sample taken from Black Butte in the Summer on the Lake's Surface.

Appendix B: Profile Data and Charts (Secchi Disc, Temperature, DO, and pH)


Lake Isabella - Temperature Profile
Depth (Ft)
0
10
20
30
40
50
60
70
80
90
100
0
5
10
15
20
25
Temperature (Degrees C)
April
August


Lake Isabella - Dissolved Oxygen Profile
Depth, ft
0
10
20
30
40
50
60
70
80
90
100
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)
April
August

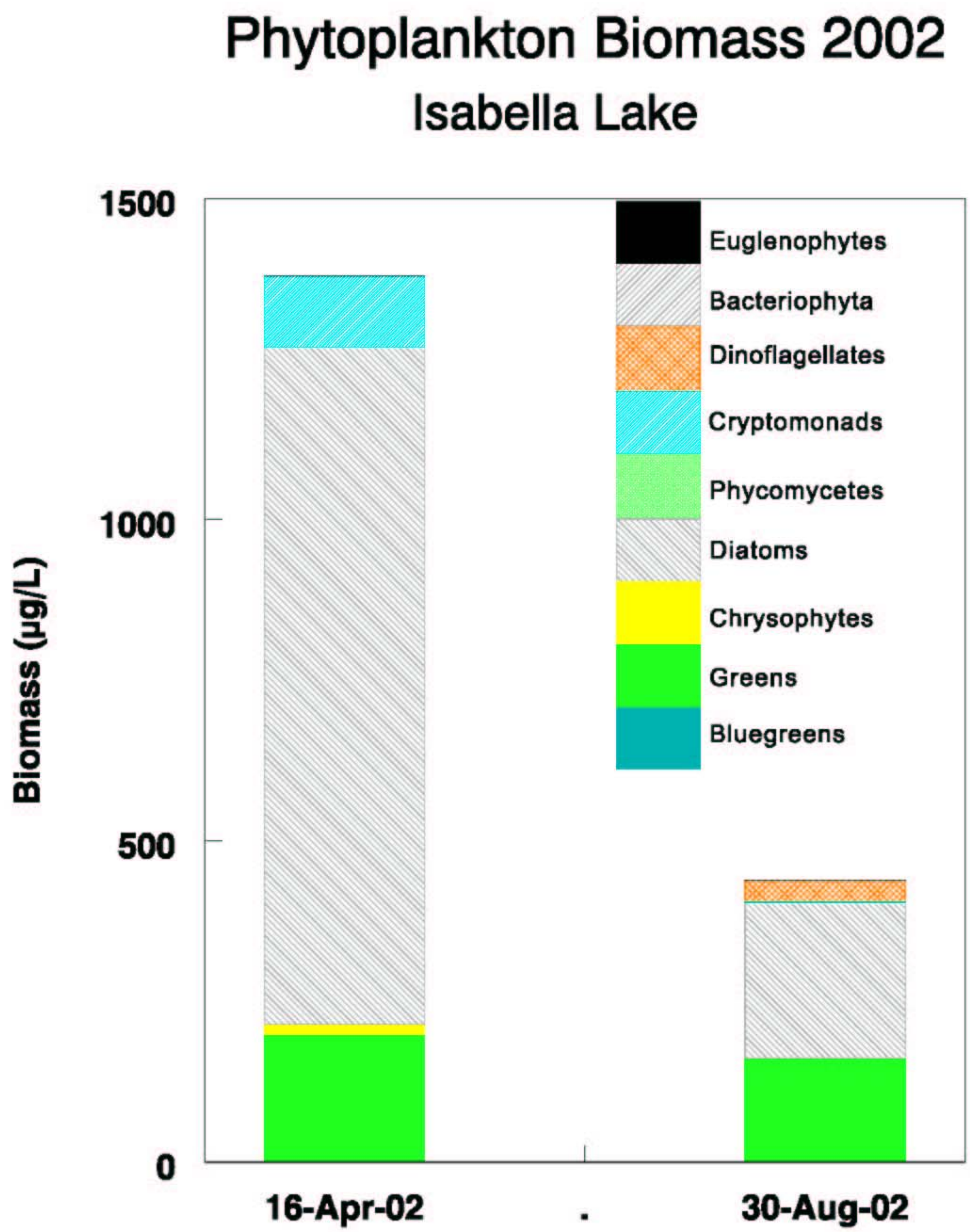


Lake Isabella - pH Profile
Depth (Ft)
0
10
20
30
40
50
60
70
80
90
100
6.9
7
7.1
7.2
7.3
7.4
7.5
7.6
7.7
7.8
pH
April
August

LAKE ISABELLA					
Sample Location: Behind dam				**Date:** 4/16/02	
Observers: Tim McLaughlin				**Time:** 9:00 am	
Lake Elevation: 2552.88					
Weather Conditions:					
Wind Speed: 5		**Precipitation:**0		**Temp (F):** 58	
SECCHI Depth: 2 feet and 10 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
27	91.9	10.57	129	5.61	7.57
26	85.3	11.05	125	6.74	7.62
24	78.7	11.58	122	7.31	7.68
22	72.2	12.11	120	7.59	7.70
20	65.6	12.72	119	7.78	7.73
18	59.1	13.21	117	7.94	7.73
16	52.5	13.76	113	8.57	7.73
14	45.9	13.83	114	8.62	7.70
12	39.4	13.88	113	8.68	7.71
10	32.8	13.91	113	8.81	7.73
8	26.2	13.94	113	9.08	7.72
6	19.7	14.00	112	9.50	7.71
4	13.1	14.03	111	9.59	7.71
2	6.6	14.04	111	9.65	7.71
0.03	1	14.05	111	10.10	7.69
SOUTH FORK KERN (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
53.8	8.4		-	-	50
NORTH FORK KERN (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
54.6	8.64		-	-	1599
VISUAL OBSERVATIONS: Water very cloudy due to high inflows.					

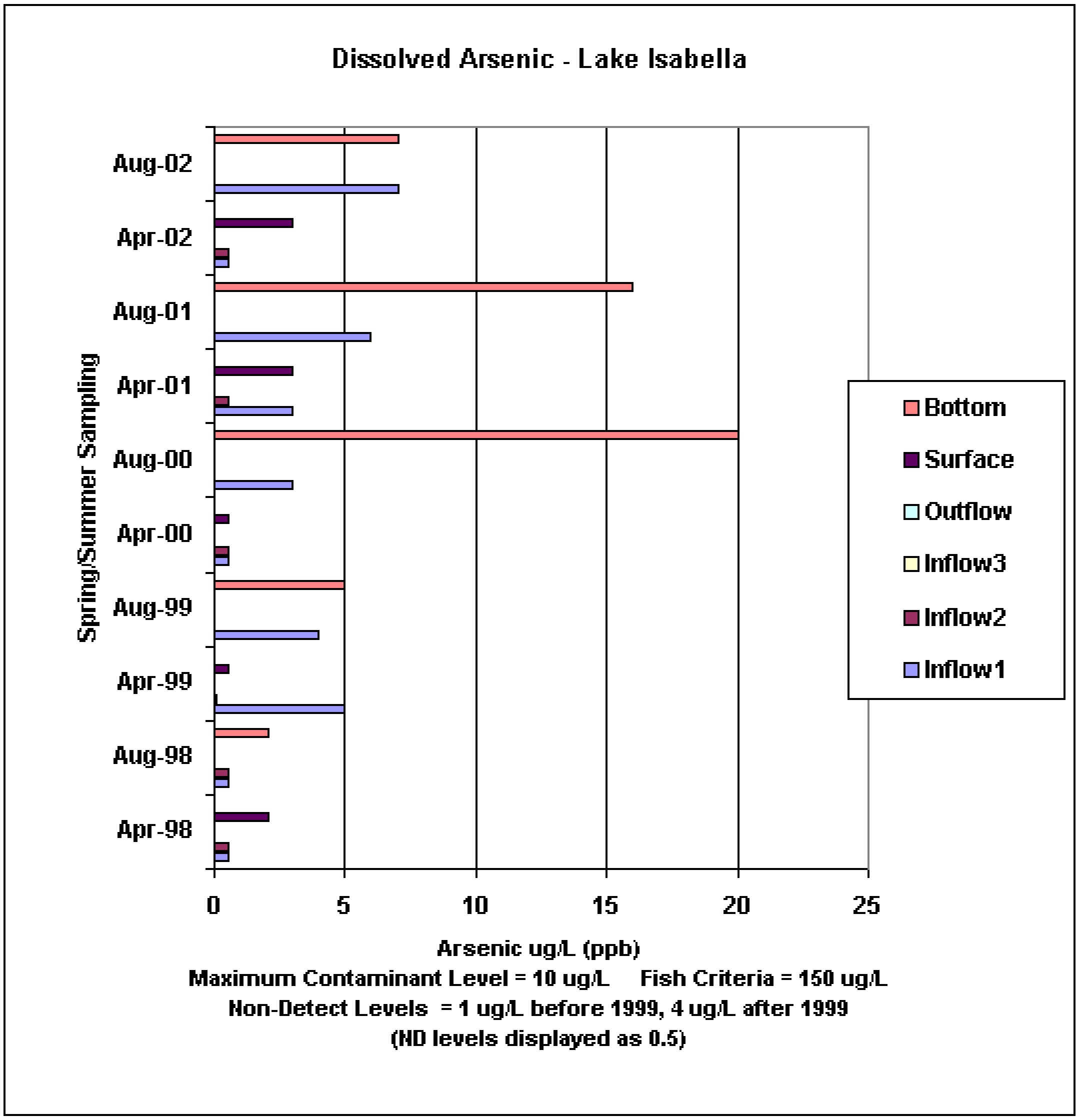
LAKE ISABELLA					
Sample Location: Behind dam				**Date:** 8/20/02	
Observers: Tim McLaughlin				**Time:** 9:30 am	
Lake Elevation: 2549					
Weather Conditions:					
Wind Speed: 20		**Precipitation:** 0		**Temp (F):** 75	
SECCHI Depth: 5 feet and 4 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
24.3	78.7	21.96	115	3.41	7.15
22	72.2	22.01	114	3.93	7.29
20	65.6	22.01	114	3.96	7.28
18	59.1	22.03	114	393	7.29
16	52.5	22.04	113	3.87	7.38
14	45.9	22.06	113	3.83	7.47
12	39.4	22.05	113	3.81	7.41
10	32.8	22.07	113	3.79	7.38
8	26.2	22.06	114	3.75	7.35
6	19.7	22.06	114	3.74	7.32
4	13.1	22.08	114	3.72	7.18
2	6.6	22.10	114	3.73	7.07
0.03	1	22.17	114	3.76	7.03
SOUTH FORK KERN (Inflow) - DRY					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
-	-		-	-	-
NORTH FORK KERN (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
77.1	8.19		-	-	138
VISUAL OBSERVATIONS: Very windy.					

Appendix C: Phytoplankton Data and Charts

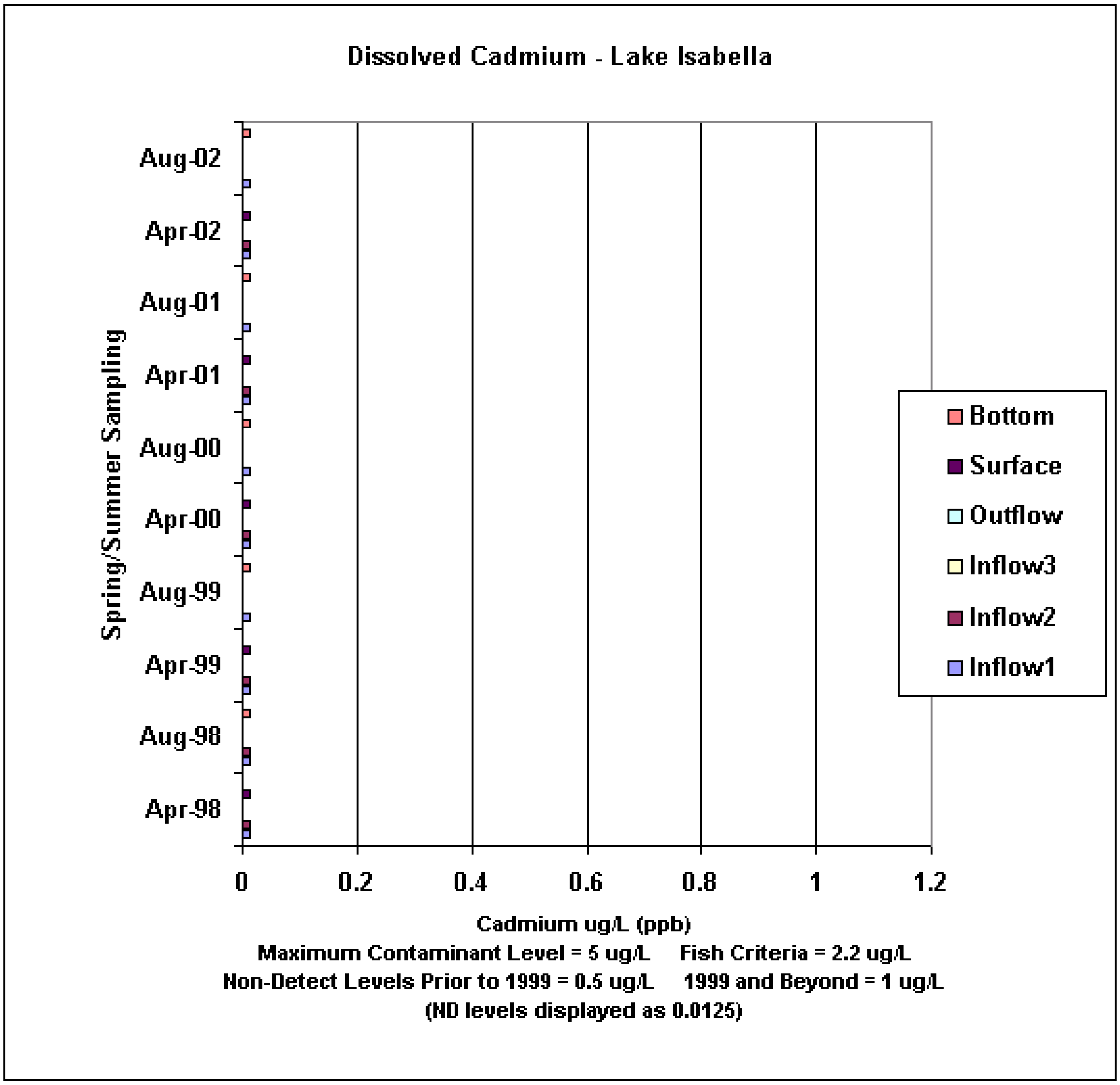


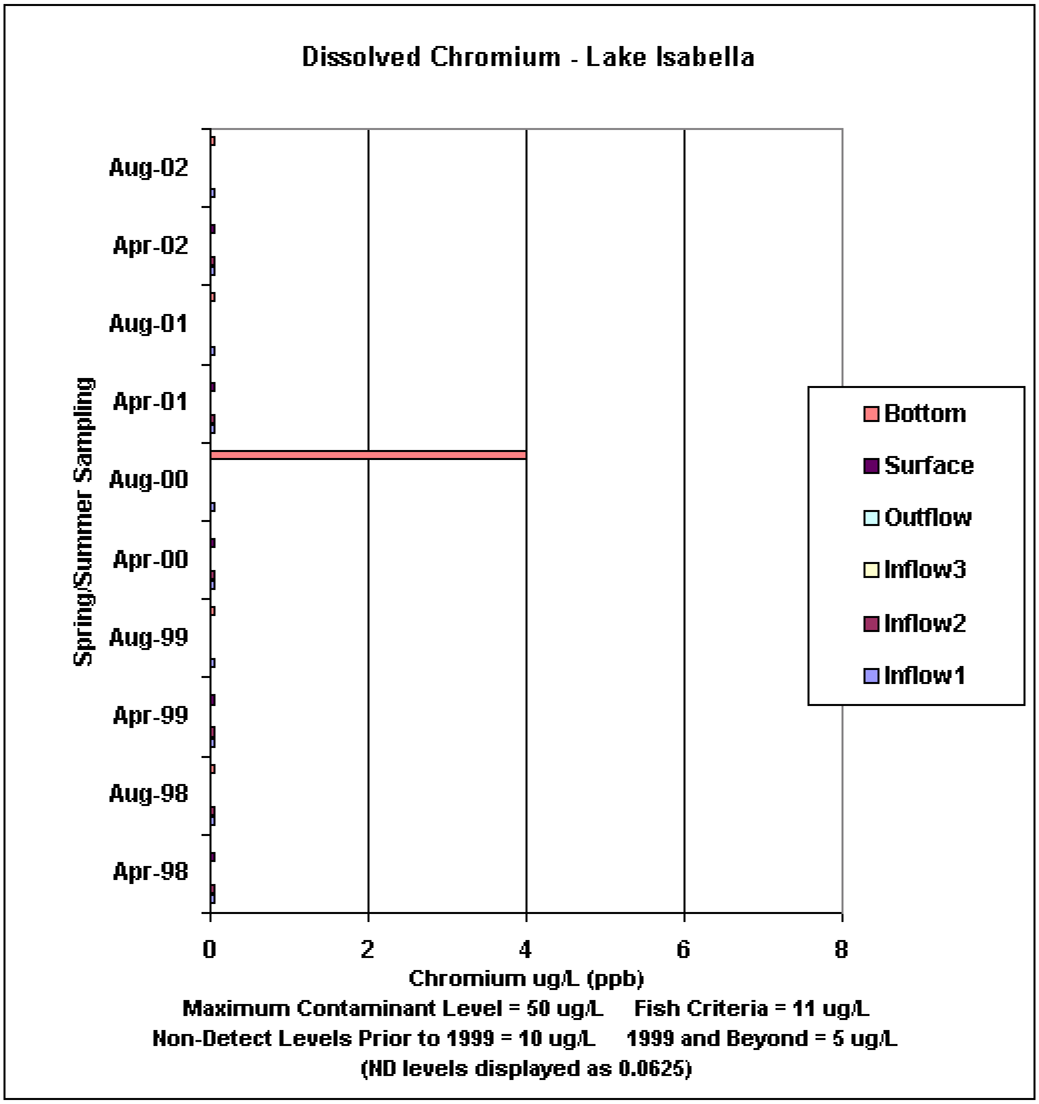
Phytoplankton Biomass 2002
Isabella Lake
Biomass (µg/L)
1500
1000
500
0
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
16-Apr-02
.
30-Aug-02

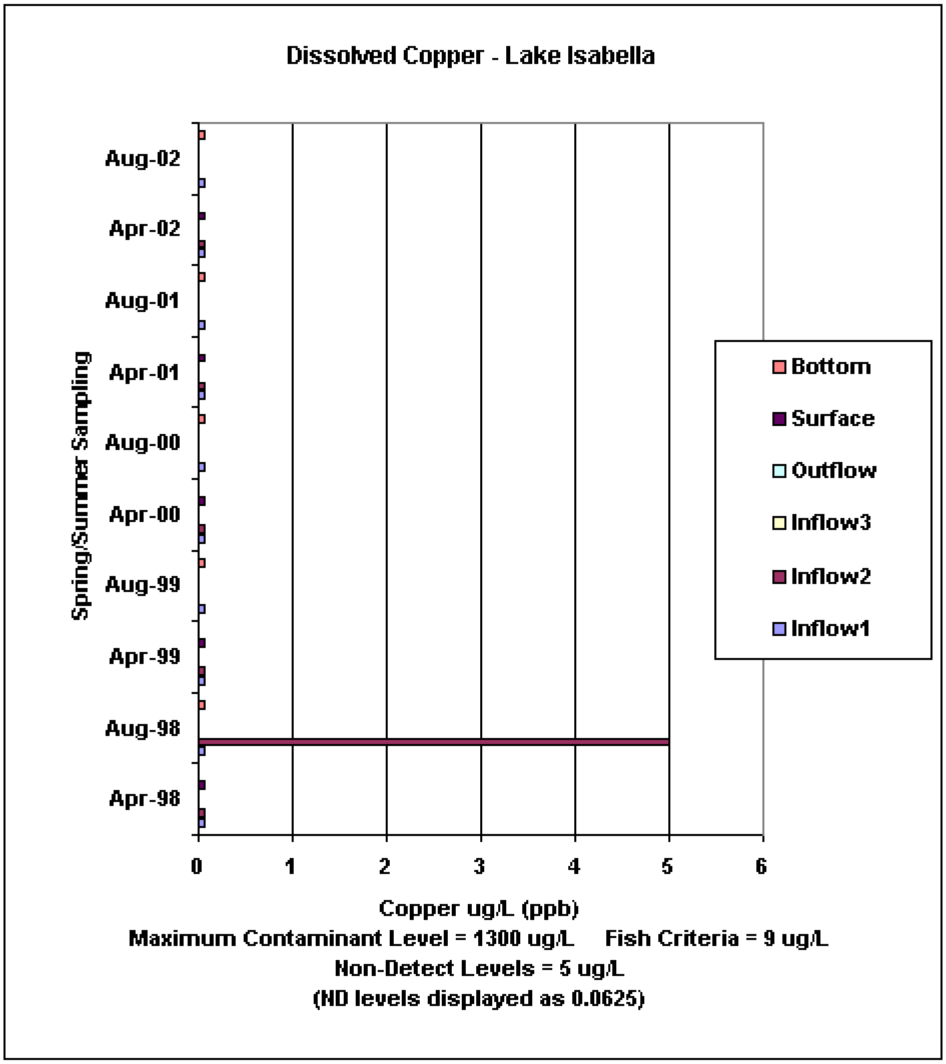
Appendix D: Metals Data and Charts

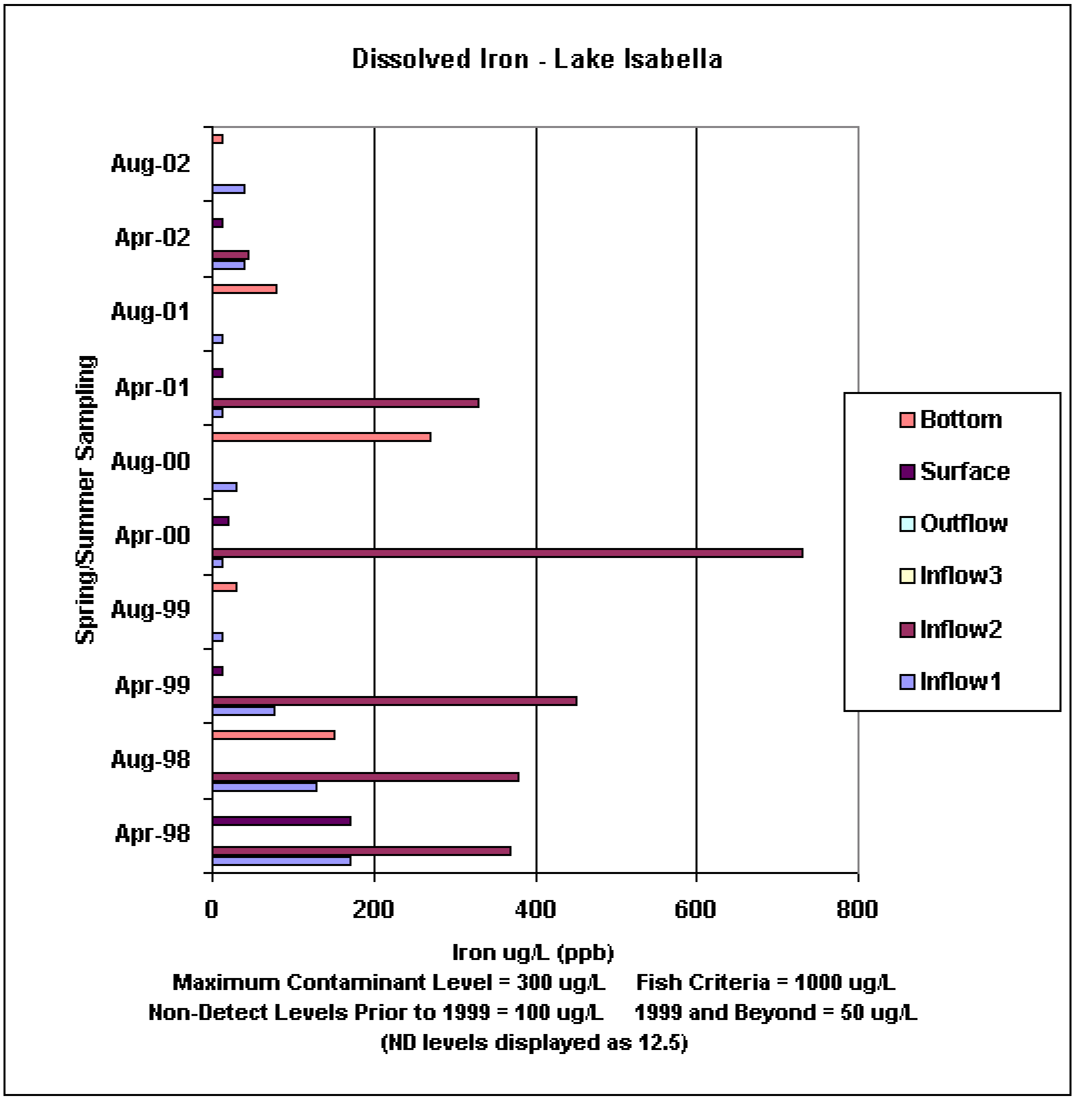


Dissolved Arsenic - Lake Isabella
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
5
10
15
20
25
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Arsenic ug/L (ppb)
Maximum Contaminant Level = 10 ug/L Fish Criteria = 150 ug/L
Non-Detect Levels = 1 ug/L before 1999, 4 ug/L after 1999
(ND levels displayed as 0.5)

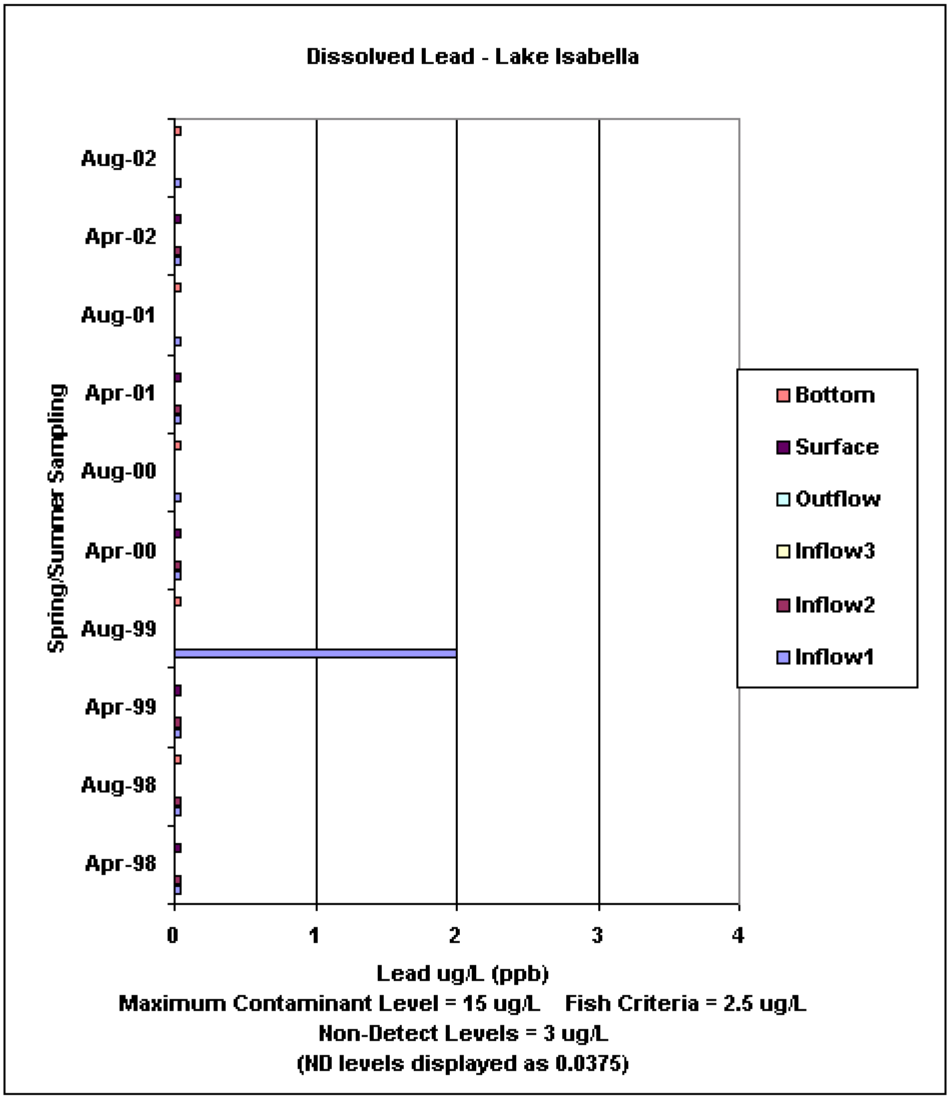

Dissolved Cadmium - Lake Isabella
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.2
0.4
0.6
0.8
1
1.2
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Cadmium ug/L (ppb)
Maximum Contaminant Level = 5 ug/L Fish Criteria = 2.2 ug/L
Non-Detect Levels Prior to 1999 = 0.5 ug/L 1999 and Beyond = 1 ug/L
(ND levels displayed as 0.0125)

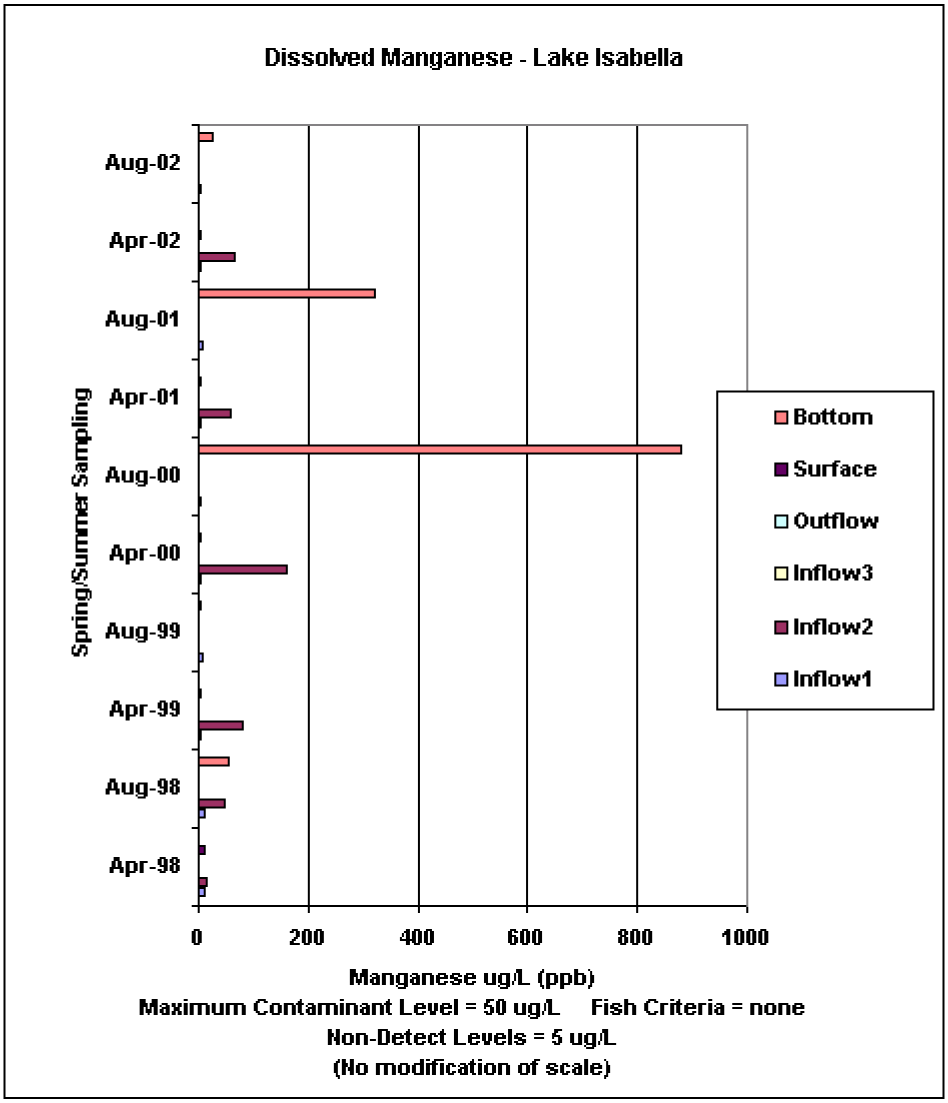

Dissolved Chromium - Lake Isabella
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Chromium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L
Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L
1999 and Beyond = 5 ug/L
(ND levels displayed as 0.0625)

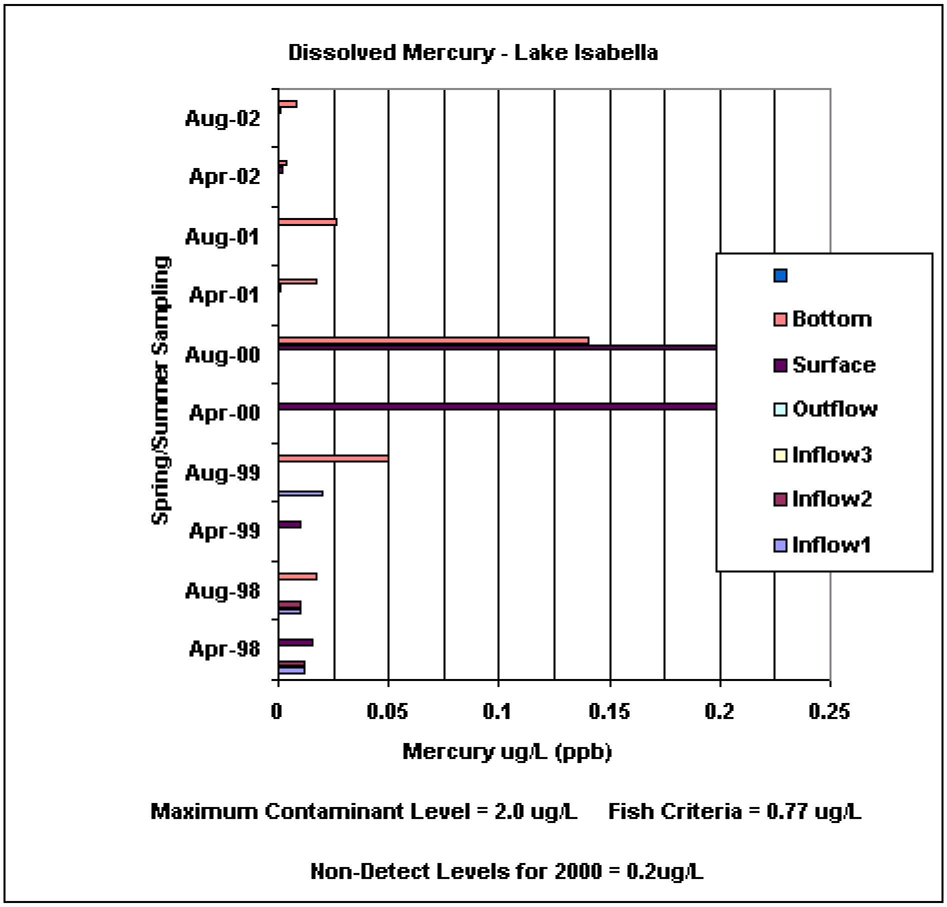

Dissolved Copper - Lake Isabella
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
5
6
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Copper ug/L (ppb)
Maximum Contaminant Level = 1300 ug/L Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L
(ND levels displayed as 0.0625)



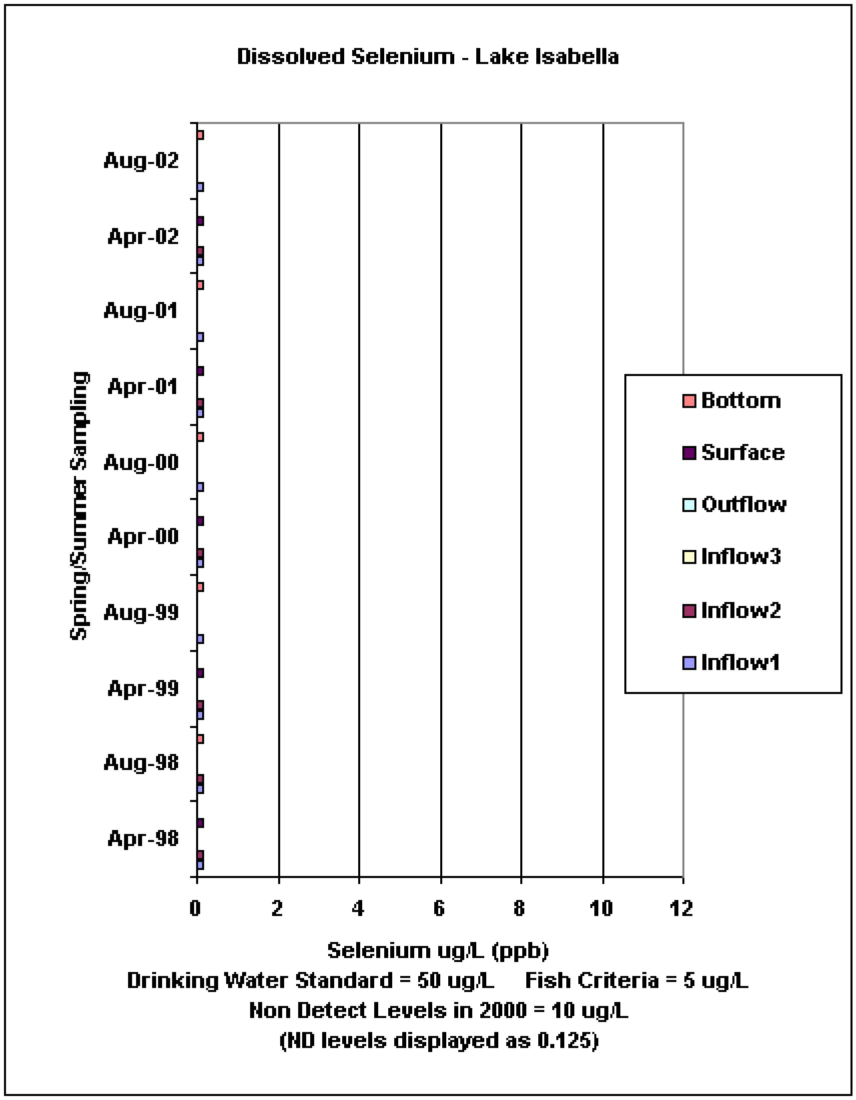
Dissolved Iron - Lake Isabella
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
200
400
600
800
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Iron ug/L (ppb)
Maximum Contaminant Level = 300 ug/L
Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L
1999 and Beyond = 50 ug/L
(ND levels displayed as 12.5)


Dissolved Lead - Lake Isabella
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
1
2
3
4
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Lead ug/L (ppb)
Maximum Contaminant Level = 15 ug/L Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L
(ND levels displayed as 0.0375)

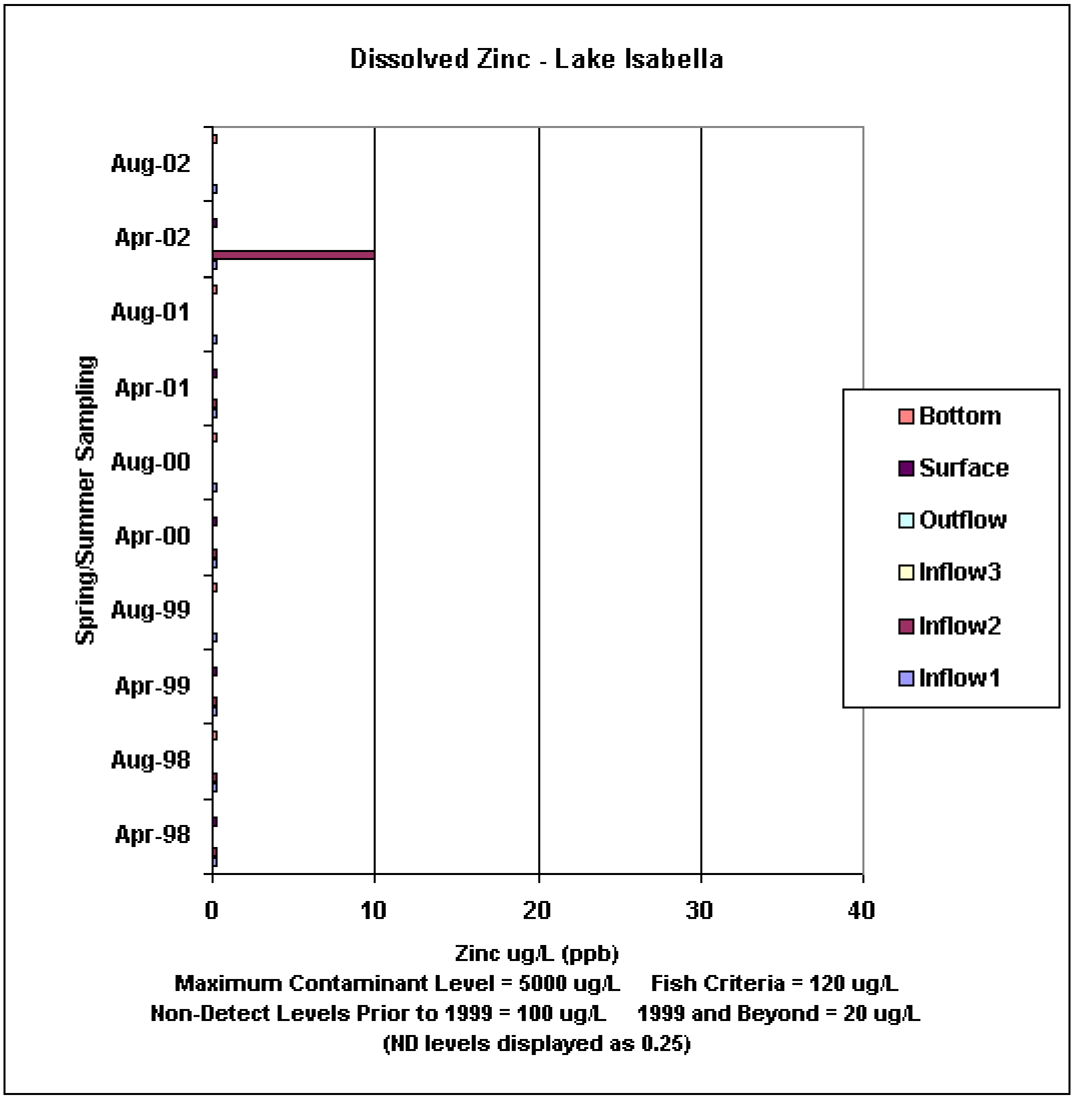

Dissolved Manganese - Lake Isabella
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
200
400
600
800
1000
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Manganese ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = none
Non-Detect Levels = 5 ug/L
(No modification of scale)



Dissolved Mercury - Lake Isabella
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
0.05
0.1
0.15
0.2
0.25
Mercury ug/L (ppb)
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Maximum Contaminant Level = 2.0 ug/L
Fish Criteria = 0.77 ug/L
Non-Detect Levels for 2000 = 0.2ug/L



Dissolved Selenium - Lake Isabella
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
2
4
6
8
10
12
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Selenium ug/L (ppb)
Drinking Water Standard = 50 ug/L Fish Criteria = 5 ug/L
Non Detect Levels in 2000 = 10 ug/L
(ND levels displayed as 0.125)



Dissolved Zinc - Lake Isabella
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
10
20
30
40
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Zinc ug/L (ppb)
Maximum Contaminant Level = 5000 ug/L   Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L   1999 and Beyond = 20 ug/L
(ND levels displayed as 0.25)

Appendix E: Inorganic Sample Data

Inorganic Results (mg/L) For surface lake waters (spring)

	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity		60	40	50	60	30	40	70	80	20		100
Ammonia		<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Chloride		21	2	21	4	4	3	<1	6	5		4
Nitrate		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1		<0.1
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Sulfate		5.3	2.6	4.2	8.9	2	1	8.2	9	2.1		4.7
Kjeldahl N		0.6	0.1	0.4	0.2	<0.1	0.3	0.2	0.2	0.2		<0.1
COD					<50							
Tot Solids		120	70	100	110	60	78	100	120	21		150

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)

	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	100	70	40	50	20	30	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	13	25	3	21	<1	<1	4	<1	6	4	3	2
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	
Sulfate	18	2.1	2.3	3	2.8	1.9	0.8	8.8	11	1.6	11	3.5
Kjeldahl N	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1
COD	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	170	130	59	110	60	60	90	110	150	30	130	90

Inorganic Results (mg/L) For surface lake waters (summer)

	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	140	70	40	50	50	40	70	90	80	10	80	110
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
Chloride	16	26	4	19	6	5	5	5	9	3	5	8
Nitrate	<0.1	1.5	<0.1	1.3	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1
Total P	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	16	4.1	3.6	3.5	5.9	2	0.7	7.4	14	1.6	6.4	4.4
Kjeldahl N	<0.1	2.7	<0.1	0.4	0.4	0.3	<0.1	0.2	<0.1	<0.1	0.2	0.6
COD	<50	60	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	200	190	50	120	98	80	80	120	120	52	100	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)

	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	90	40		60	40	80	100	130	20	110	180
Ammonia												
Chloride	16	490	5		10	8	3	5	14	4	5	22
Nitrate												
Total P												
Ortho P												
Sulfate	16	4.5	3		9.8	3.2	<0.5	6	14	2.7	5.4	8.7
Kjeldahl N												
COD												
Tot Solids	200	1300	50		140	100	100	150	200	50	140	280

Appendix F: MTBE Table

2002 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2002 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	2		2		<2		<2		
Eastman	5				<2				
Englebright	3		3		10		10	10	
Hensley	3		3		3		3		
Isabella	<2	<2	<2	<2	<2	<2	<2	<2	
Kaweah	2		2	<2	8		6	6	
Martis Cr.	<2				<2				
Mendocino	<2				<2				
New Hogan	<2				3				
Pine Flat	<2		<2		2		2		
Sonoma		3	<2		<2		2		
Success	4		4	4	11	12	11	11	

Notes:

1. Non-Detect is indicated by "<2" since the Reporting Limit is 2 ppb or 0.002 ppm.

2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.

3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.

4. For 2002, the number of MTBE water sampling at each lake is based on last year's lab results.

5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was historically non-detectable. The 2002 results of non-detectable levels were similar except Lake Eastman and New Hogan now reported low, detectable levels of MTBE.

6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because of historically low detectable levels of MTBE.

7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because of historically higher MTBE being found. The 2002 results were similar except Isabella now reported non-detectible levels.

8. In 2001, very high MTBE levels were reported at Lake Isabella during the Spring (18 ug/L near the marina) . During Spring 2000, Lake Isabella reported 21 ug/L. The 2002 results indicate that the previous MTBE problem near the marina was not visible during the Spring 2002 sampling event, and may have been rectified.

G. Fish tissue analysis table

2002 Fish Tissue Results

The following table provides an overview of the lab results for the 2002 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conductng the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The California OEHHA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Mercury Total ppm	FDA Criteria
Black Butte	Sm M Bass	Composite (3)	6/12/02	0.24	0.26	1 ppm
Eastman	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Englebright	Note 5	N/A	N/A	N/A	N/A	
Hensley	Black Bass	Composite (3)	4/23/02	<0.10	0.72	1 ppm
Isabella	Black Bass	Composite (3)	6/4/02	0.20	0.21	1 ppm
Kaweah	Sm M Bass	Composite (3)	7/14/02	0.11	0.53	1 ppm
Martis Cr	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Mendocino	Note 6	N/A	N/A	N/A	N/A	
New Hogan	Lg M Bass	Single (1)	6/3/02	<0.10	0.34	1 ppm
Pine Flat	Note 4	--------------------	-----------	----------	-----------	< Mon 01
Sonoma	Note 6	N/A	N/A	N/A	N/A	
Success	Black Bass	Composite (3)	4/15/02	<0.10	0.18	1 ppm

Notes:

9. Non-Detect is indicated by "<0.02". The lab Detection Limit for mercury is 0.02 ppm.
10. Total Mercury was reported in mg/g or ppm.
11. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.
12. The fish tissue program was terminated at Eastman and Martis Creek in 2001 and in Pine Flat in 2002 due to low total mercury results. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout). For Pine Flat total mercury was 0.21 ppm in 2000 (composite of three Sacramento Sucker fish) and 0.23 in 2001 (composite of three spotted bass).
13. Due to seasonal conditions, a fish could not be successfully collected at Lake Englebright. Another attempt will be accomplished for the 2003 report.
14. Fish were not collected at Mendocino or Sonoma due to communication difficulties.

The above 2002 total mercury results indicate only Hensley is higher than average. However, in 2001, the total mercury results were only 0.30 ppm for Hensley (small mouth bass). The 2003 fish tissue program should provide additional data. EPA fact sheet on fish advisories (EPA-823-F-99-016) indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.

Annual Water Quality Report

MARTIS CREEK LAKE

Water Year 2002

Written by
John J. Baum
Water Quality Engineer
U. S. Army Corps of Engineers
Sacramento District
January 2003

TABLE OF CONTENTS

Martis Creek Lake

I. Purpose

This report is part of an environmental monitoring program that restarted at Martis Creek Lake in April 1996. The monitoring program was implemented to ensure a continuous level of water quality in the lake for both recreation and environmental health and to satisfy the Department of Army Engineering Regulation 1110-2-8154, “Water Quality and Environmental Management for Corps Civil Works Projects”.

II. Brief Description of Martis Creek Lake

Martis Creek Lake is located in the Sierra Nevada Mountains near Lake Tahoe, 6 miles southeast of Truckee, California. The lake was created upon the completion of Martis Creek Dam in 1972. At capacity, the lake has 770 surface acres and holds 20,400 acre-feet of water. The dam is 113 feet high and 2,670 feet long. Since being built for flood control and irrigation, the lake has become a popular destination for recreation. Due to winter weather conditions, the park is closed Nov. 15 through the last Saturday in April.

Water quality monitoring by the United States Army Corps of Engineers (USACE) initially began at Martis Creek Lake in August 1974, but was ended in September 1978. In April 1996, monitoring was reinitiated at Martis Creek Lake and has continued successfully. Generally there are two sample events a year, spring (April) and late summer (August). Since the start of the monitoring program, a water quality report is produced yearly to list results and address any concerns of the previous water year.

Generally Martis Creek Lake has a depth of less than 25 feet during the sampling events, and is considered a mesotrophic lake when characterized by its clarity. A mesotrophic lake is one that has qualities in between an oligotrophic (clear and nutrient limited, example Lake Tahoe) and an eutrophic lake (low clarity and high in nutrients, example Clear Lake). Unlike many of the lakes that are monitored by the USACE, Martis Creek Lake can maintain aerobic conditions (available dissolved oxygen, DO) at the bottom depths during warm late summer months. Martis Creek Lake is cool (<20ºC) in the late summer. Due to both the cool late summer temperatures and relativly high dissolved oxygen concentrations in the lake year-round, coldwater fish species could survive in the lake year round. Coldwater fish species include various species of trout. Although clearer than eutrophic (nutrient rich) lakes, mesotrophic lakes also can have low water clarity due to algal blooms and sediments suspended by wind action. Water clarity is often measured in terms of Secchi Disc depth or SD (Appendix A). Historically, the water clarity in Martis Creek Lake is good with only ~14.3 % of the samples not meeting the recreational goal of 4 feet or greater (Figure 1). In 2001 the Spring SD measure was 11.5 feet, while the late summer sample was below the recreational goal with a SD value of 2.5 feet.

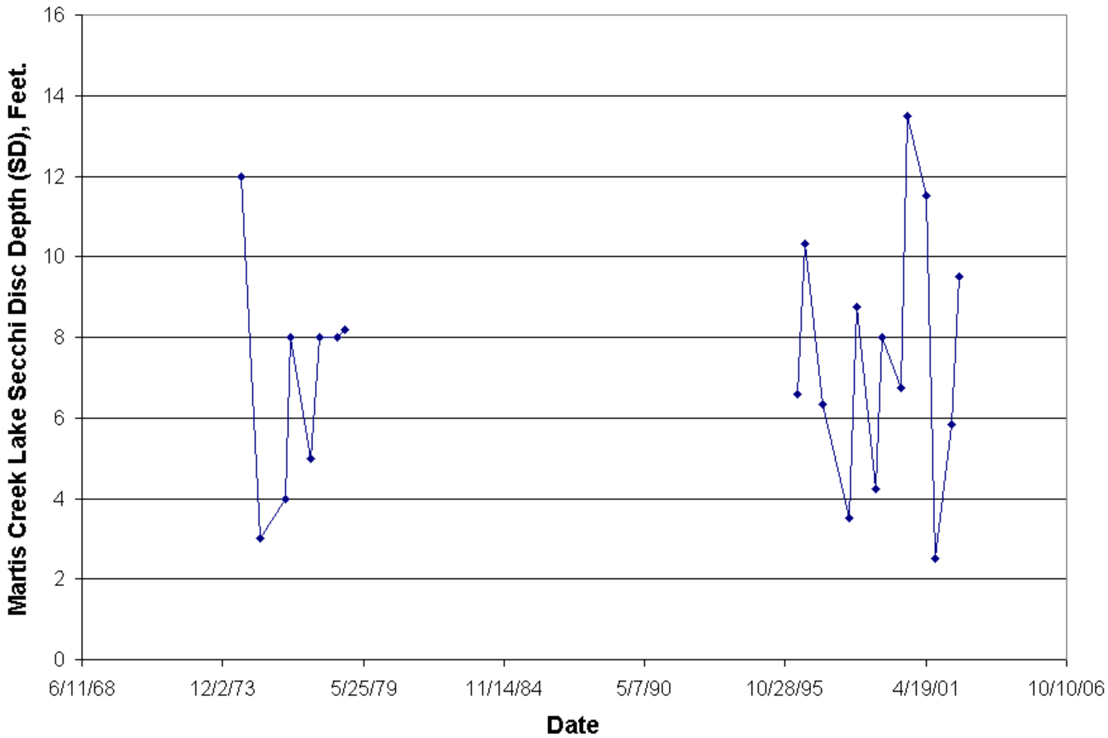


Figure 1. Historical Secchi Depth Values at Martis Creek Lake (2002 values included).

The 2001 Water Quality Report listed no contaminants of concern at Martis Creek Lake, but summer pH values and algal biomass concentrations had unexpected results. These issues will be examined in this 2002 water quality report.

III. Sample Summaries for this year.

Introduction

The following general summaries are split into their respective sample types. Each type of sample summary includes a discussion of both the spring (April) and late summer (August) samples to better examine trends within the current year. The types of parameters monitored this year include: Secchi Disc depths, water column profiles (temperature, DO and pH), phytoplankton characterization, metals concentrations, MTBE concentrations, and Inorganic characterization (alkalinity, phosphorous, nitrogen, etc..). Fish mercury sampling was ceased in 2000 due to the low concentrations found within the fish samples. For a more detailed explanation of the importance of each type of sample, please see Appendix A.

SECCHI DEPTH

The Secchi Disc depth found during the spring was higher than the historical average (historical mean SD = 7.3 feet), while the late summer SD was below the mean. More often the clarity is better in the late summer than in the late spring, but sometimes the spring is clearer. In spring the water clarity was low and the SD was 5.83 feet, which was less than the previous year (2001 Spring SD = 11.25 feet). The late summer SD of 9.5 feet was above the recreational goal of 4 feet and much greater than the previous year (Summer 2001 SD = 2.5) (Appendix B).

TEMPERATURE VALUES

The temperature profiles for Martis Creek Lake are indicative of a well-mixed shallow lake. The lake is semi stratified in the spring, but the layers disappear by the warm temperatures of late summer. There is no difference in the depth of the lake between the spring and late summer sampling events (spring depth = 19.7 feet, late summer depth= 19.7 feet), but the average temperatures were very different (spring average temp. = 9.81 ºC, late summer average temp.= 18.66 ºC). Martis Creek Lake does not have a cooler deep-water area to buffer it from the warm summer air temperatures. Due to the being at a higher altitude Martis Creek Lake was able to maintain a relatively cool temperature by the late summer sampling event. Martis Creek Lake should be able to support coldwater fish species. For detailed results obtained during the sampling events, please see Appendix B.

DISSOLVED OXYGEN

The dissolved oxygen (DO) concentration differs from spring to late summer. In the spring DO concentrations are 10.25 mg/L near the surface and 8.26 mg/L at the bottom of the lake. DO concentrations near the surface are near saturation, which is10.98 mg/L at 11.83 ºC. DO concentrations in the late summer are lower and were surprisingly lower near the surface (DO = 3.54 mg/l) and was higher near the bottom of the lake (DO = 7.11 mg/l). Fish species that require greater than 5 mg/l DO at cooler water temperatures (< 20ºC) would be likely to survive year round in Martis Creek Lake. For detailed results obtained during the sampling events, please see Appendix B.

PH Levels

In the spring sample event, pH values in the lake were slightly basic (pH = ~7.7) throughout the water column. The pH values in the late summer profile varied widely and were more basic. The pH was highly basic towards the middle waters (max pH = 9.84) and slightly less basic at the top and bottom (pH near surface = 8.33, pH bottom = 9.12). For detailed results obtained during the sampling events, please see Appendix B.

PHYTOPLANKTON

In the spring sample, the algal biomass within the lake was very high (Biomass = 6101.65 ug/L) compared to spring 2001 (2001 Spring biomass = 160.37 ug/L). In spring 2001 and 2002 diatoms were the most dominant species. In late summer the opposite trend occurred and the phytoplankton population was much lower in summer 2002 (2002 Summer Biomass = 3,939.0 ug/L) than summer 2001 (2001 Summer Biomass = 23,014.42 ug/L). Diatoms were the most dominant species during the 2002 late summer sampling events, but blue-green algae dominated in summer 2001. While most phytoplankton species must obtain nitrogen (a required nutrient for growth) from aqueous forms in the lake, blue-green algae have the ability to use the atmospheric form or nitrogen gas (nitrogen fixation). In lakes that are limited in nitrogen availability, nitrogen fixing is a distinct advantage. Blue-green algae is often thought of as a nuisance due to the inability of it to be used in the aquatic food chain and for its impact on water clarity. For detailed results obtained during the 2002 sampling events, please see Appendix C.

METALS

Only one of the dissolved heavy metal samples exceeded the maximum contaminant level (MCL) or the freshwater fishery criteria during either the 2002 spring and summer sampling events. In one late summer lake influent sample the concentration of iron (Spring Fe influent = 330 ppb) was higher than the Secondary MCL (Fe Secondary MCL = 300 ppb), but not higher than the fish criteria concentration (1000 ppb). Contaminants will continue to be monitored in the coming year for any changes. For detailed results obtained during the sampling events, please see Appendix D.

MTBE

Concentrations for MTBE around the lake were found to be below the detection limit (< 2 ppb) during both spring and late summer sampling events. For detailed results obtained during the sampling events, please see Appendix F.

INORGANIC ANALYSIS

The spring and summer sample results were within expected ranges and levels. For detailed results obtained during the 2002 sampling events, please see Appendix E.

IV. Conclusions

Martis Creek Lake is a shallow mesotrophic lake that can support coldwater fish species due to being at a higher (and cooler) elevation. Coldwater fish that require temperatures below 20 C and dissolved oxygen concentrations greater than 5 mg/L should be able to survive the conditions at Martis Creek Lake.

In the 2002 Martis Creek Lake sampling events only dissolved iron was a contaminant of concern. Iron concentrations were above the Secondary MCL for drinking water in one lake influent sample during the late summer.

A parameter that may require additional monitoring in the upcoming year is pH. The pH in Martis Creek Lake during the summer was very high (average summer pH= 9.28).

V. References

North American Lake Management Society (1990). *Lake and Reservoir Restoration Guidance Manual*, EPA 440/4-90-006, U.S. Environmental Protection Agency, Washington, DC.

Novotny, V., and H. Olem (1994). *Water Quality: Prevention, Identification, and Management of Diffuse Pollution*, Van Nostrand Reinhold, New York, New York.

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Welch, E.B. (1992) *Ecological Effects of Wastewater: Applied limnology and pollutant effects,* Chapman and Hall, Cambridge University Press, Great Britain.

Wetzel, R.G. (1975). *Limnology*, W.B. Saunders Company, Philadelphia, PA.

VI. Appendices

Appendix A: Glossary of Sample Types

Glossary of Sample Types

This glossary of sample types is intended to provide a general background and indicate the importance of each sample in determining water quality. These are meant to be brief and basic. If a further explanation is desired please refer to the list of references provided in this report.

Secchi Depth

One of the oldest and easiest methods to determine lake clarity is the Secchi depth (SD). The Secchi depth is determined by dropping a Secchi disc into a water body and determining the depth that it is last visible from the surface of the water. Secchi discs are generally white and 20 cm in diameter. Secchi depth values are most impacted by the light intensity at the time of sampling and the scattering of light by solid particulates within the water column. Algal growth (phytoplankton) and sediment re-suspension are often major constituents of solid particulates within the water column. Secchi depth values can be used to estimate the Trophic state or the nutrient levels within the lake. The more nutrients are available, the larger likelihood of algal blooms that limit water clarity. Due to recreational concerns for safety, the goal for Secchi depth values is four feet or greater.

Temperature Profiles and Data Points

The temperature profile of a lake provides information how a lake is operating and the potential for aquatic biota to live within the lake. The temperature profile is a direct indicator if a lake is stratified. Stratification in lakes is created generally by temperature affecting the density of water molecules. Stratification is usually indicated by a region of similar temperature nearer the surface of the water (epilimnion), then a region of temperature transition (metalimnion), to another layer of nearly constant temperature at the bottom of the lake (hypolimnion). Each layer in a stratified lake is important, but the existence of a hypolimnion can drastically impact how well a lake can handle warmer temperatures such as those found in northern California during the summer. The hypolimnion acts as a buffer against large temperature shifts. The nature of dam operation is that water is discharged near the bottom, releasing the hypolimnion, and eliminating stratification. This operation limits the ability of reservoirs to regulate their temperature during the summer months. Stratification isn't always desirable. When a lake isn't stratified and is instead well mixed, the required nutrients near the bottom of the lake become available to phytoplankton for growth. Temperatures within lakes also indicate which species of fish will survive within a lake. Coldwater species of fish require temperatures below 20 degrees C in order to spawn and survive. If a lake is often above 20 degrees C, then only warmwater fish species will survive.

Dissolved Oxygen (DO) Concentration Profiles

DO is required by organisms for respiration and for chemical reactions within lake waters. The recommended level for DO for most aquatic species survival is 5mg/L. In lakes, biota waste (detritus) falls to the bottom of the lake to be utilized by bacteria. The

bacteria need oxygen and will deplete levels near the bottom of a lake, especially during warm temperature, high respiration conditions. For nutrient rich (eutrophic) lakes more organisms will grow, create wastes, and cause oxygen depleted regions at the lowest areas. Under these conditions only aquatic species that can survive low DO conditions in warm water near the surface will survive.

PH Profiles
The pH profiles of the lakes indicate the potential for certain chemical reactions to occur. In high pH (greater than pH = 7 or basic) aquatic systems, metal pollutants tend to form into insoluble compounds that fall onto the lake floor. In low pH (less than pH = 7 or acidic) systems or areas metal ions become soluble and available for uptake into aquatic organisms. Other compounds like ammonia that are introduced into a low pH aquatic environment will transform into soluble nitrate and be utilized by organisms.

Phytoplankton Analysis
Phytoplankton analysis indicates the health, nutrients, and biodiversity within a lake. Lakes that have few nutrients available (Oligotrophic) will generally have a much lower quantity of phytoplankton (high Secchi depth) but the number of phytoplankton species seen will be large. In a lake that is nutrient rich (eutrophic) there are generally large phytoplankton blooms (low Secchi depth), but they are made up of a couple of phytoplankton species. Certain species of phytoplankton are preferred food sources for zooplankton (small invertebrates). Generally species like diatoms and green algae can be consumed by the filter-feeding zooplankton, but species like bluegreen algae are low in nutrients and are difficult to consume. Some species like the dinoflagellates can grow horn like points to discourage potential predators. In nutrient rich waters where there is plenty of phosphorous, nitrogen can be limited for biological growth. While most species can't grow due to the lack of nitrogen, bluegreen algae (cyanobacteria) have the ability to utilize nitrogen from the atmosphere when required. This gives bluegreen algae the ability to dominate in many eutrophic lakes.

Soluble Metals Analysis
The soluble metals analysis indicates the exposure of humans and aquatic organisms to toxic metals. These metals often build up as they are consumed through the food chain. Water samples provide an indicator for additional problems. Soluble forms of metal ions are more prevalent in low pH (pH <7, or acidic) environments.

MTBE Analysis
MTBE (methyl tertiary-butyl ether) is a chemical additive to gasoline to improve combustion. Due to its high solubility, MTBE travels and blends into aquatic systems rapidly. While not found to be extremely hazardous at low levels, the offensive smell and taste is detectible by humans at extremely low concentrations. The effect of MTBE on humans and aquatic systems is still under investigation.

Inorganic Analysis

Alkalinity

Alkalinity is measured in terms of mg/L of calcium carbonate. It indicates a lakes ability to buffer incoming acidic pollution and situational changes.

Ammonia

Ammonia is a gas that is toxic to fish and is more visible at a higher pH. Ammonia is created through anthropogenic inputs, bacteria cell respiration, and the decomposition of dead cells. Due to being a gas, given time ammonia will volatilize from the water. At a lower pH, much of the ammonia is converted to ammonium (a nutrient for root bound plant life) and utilizes DO in the nitrification process.

Chloride

The chloride ion is an indicator of any salinity increases within a lake. Most fresh water aquatic species are sensitive to salinity changes.

Nitrate

Nitrate is the nitrogen product created through the nitrification of ammonium. Nitrate is a soluble form of the nutrient nitrogen and is utilized by phytoplankton.

Total Phosphorous

The total phosphorous provides a measure of both utilized and soluble phosphorous within water samples. Phosphorous is a required nutrient for plant growth and development.

Ortho Phosphorous

Ortho phosphorous is the soluble form of phosphorous that is utilized by free-floating aquatic plants (phytoplankton).

Kjeldahl N

Kjeldahl nitrogen or total Kjeldahl nitrogen (TKN) is a measure of the total concentration of nitrogen in a sample. This includes ammonia, ammonium, nitrite, nitrate, nitrogen gas, and nitrogen contained within organisms.

COD

Chemical Oxygen Demand (COD) is a measure of the total oxygen required to complete the chemical and biological demands of a sample.

Fish Tissue Analysis

Fish tissue is analyzed to examine potential exposure of humans to toxicants as well as the health of the aquatic food chain. In aquatic systems toxic contaminants can build up (or bioaccumulate) within animals at the top of the food chain. Contaminants (especially organic pollutants) are retained within the fat tissue of an organism, therefore in fish samples the lipid content is often measured.

Lake Code Designation

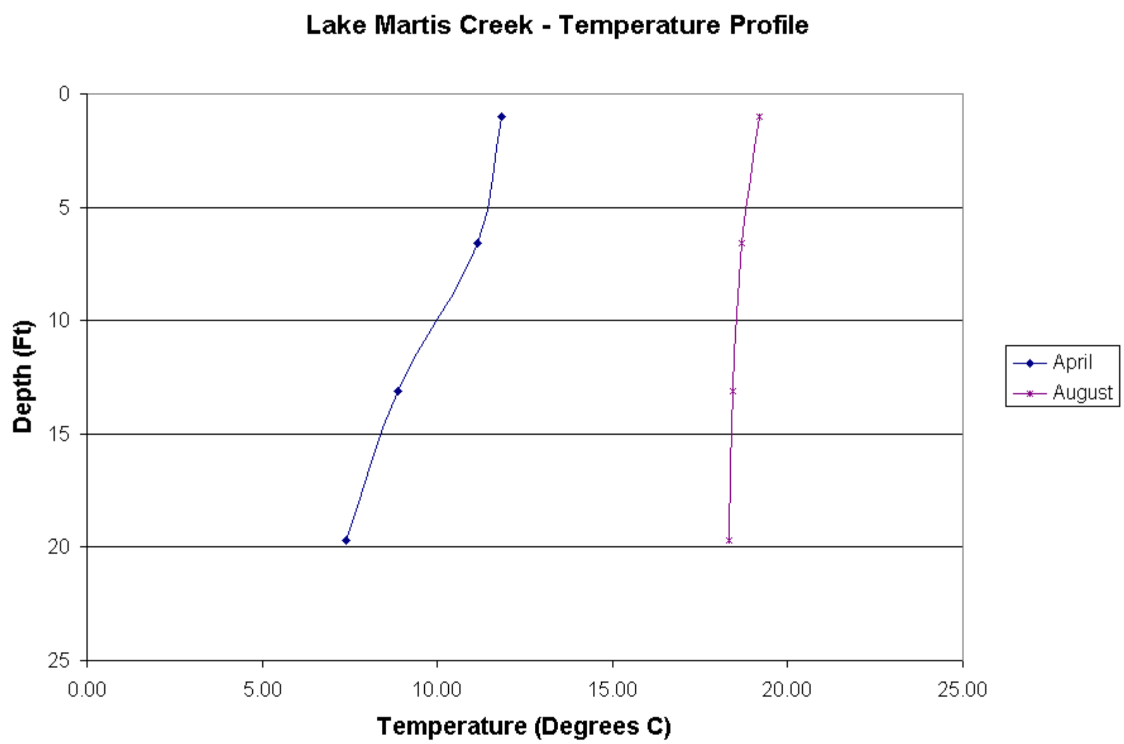
Laboratory Reports are provided in the previous sections.

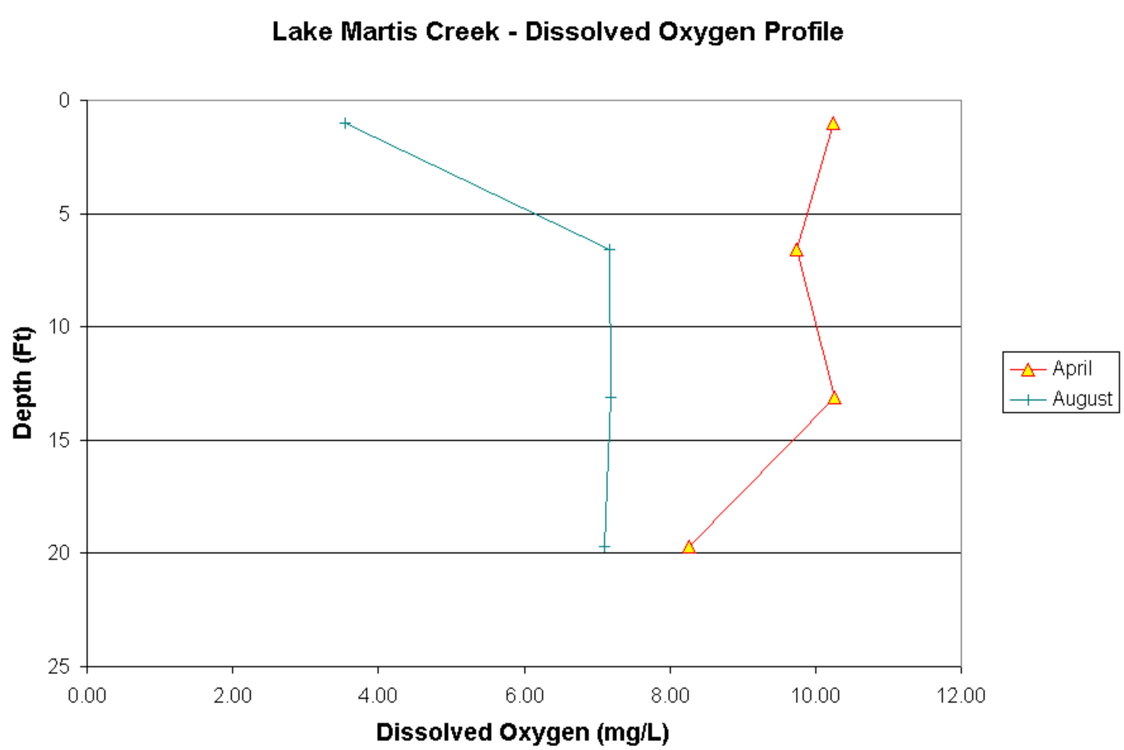
Sample ID is "XX-YY-ZZ" where

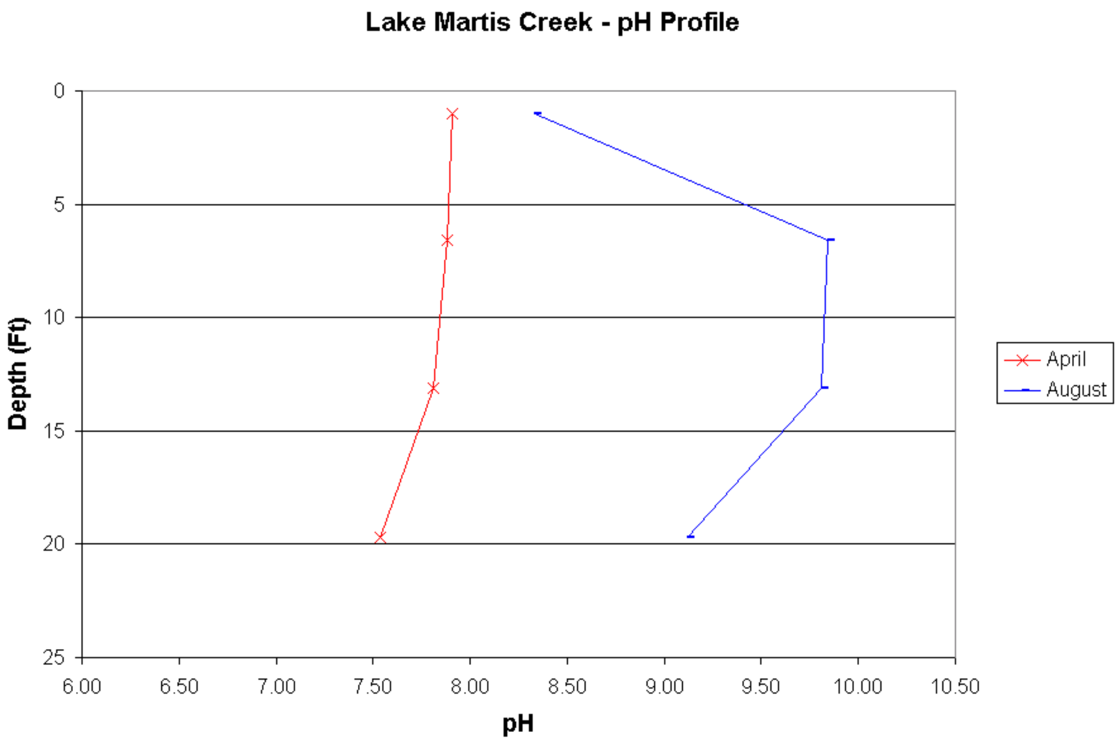
XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summar	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

Example: BB-SU-S is for a water sample taken from Black Butte in the Summer on the Lake's Surface.

Appendix B: Profile Data and Charts (Secchi Disc, Temperature, DO, and pH)


Lake Martis Creek - Temperature Profile
Depth (Ft)
Temperature (Degrees C)
April
August
0
5
10
15
20
25
0.00
5.00
10.00
15.00
20.00
25.00


Lake Martis Creek - Dissolved Oxygen Profile
Depth (Ft)
Dissolved Oxygen (mg/L)
April
August
0
5
10
15
20
25
0.00
2.00
4.00
6.00
8.00
10.00
12.00

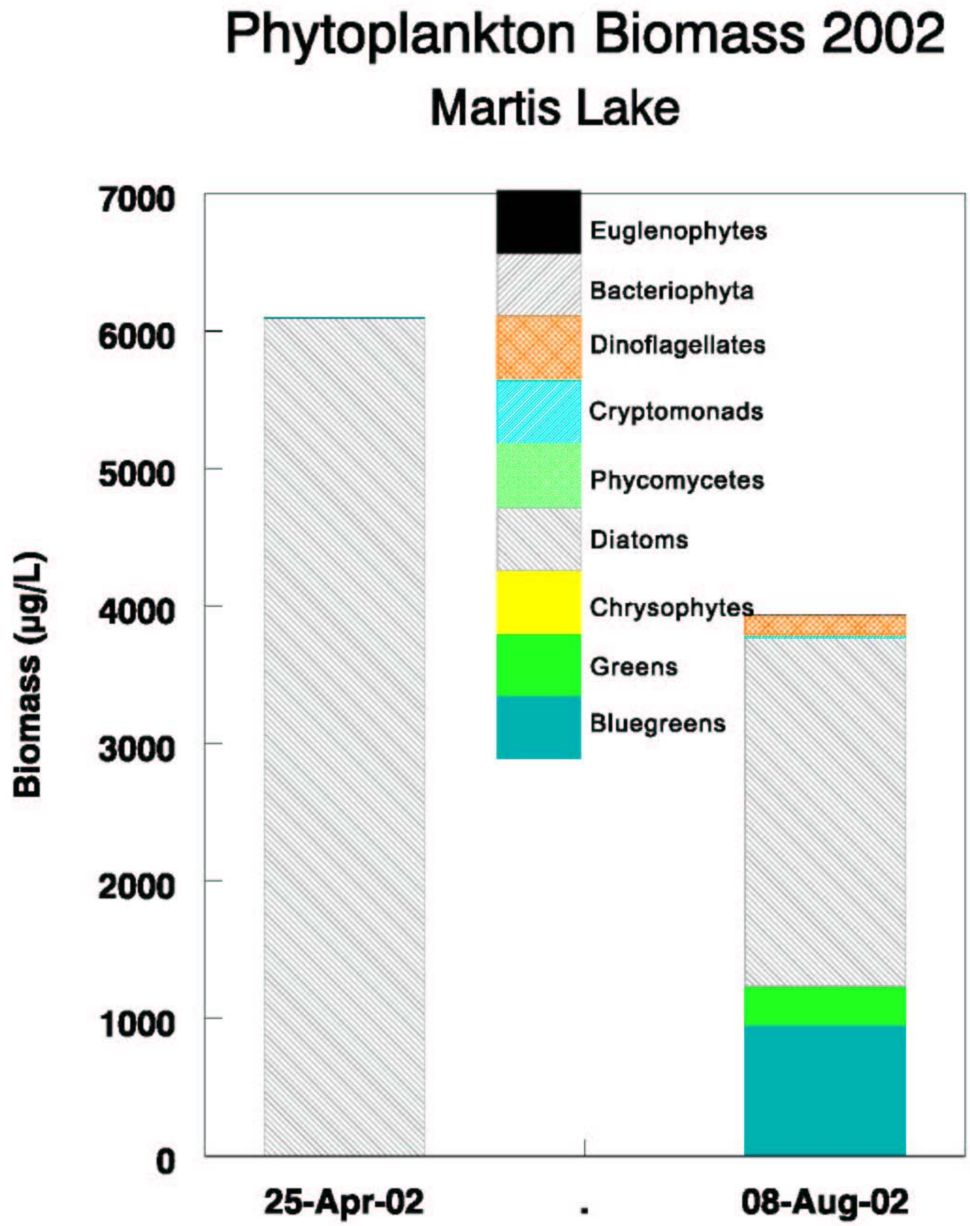


Lake Martis Creek - pH Profile
Depth (Ft)
pH
0
5
10
15
20
25
6.00
6.50
7.00
7.50
8.00
8.50
9.00
9.50
10.00
10.50
April
August

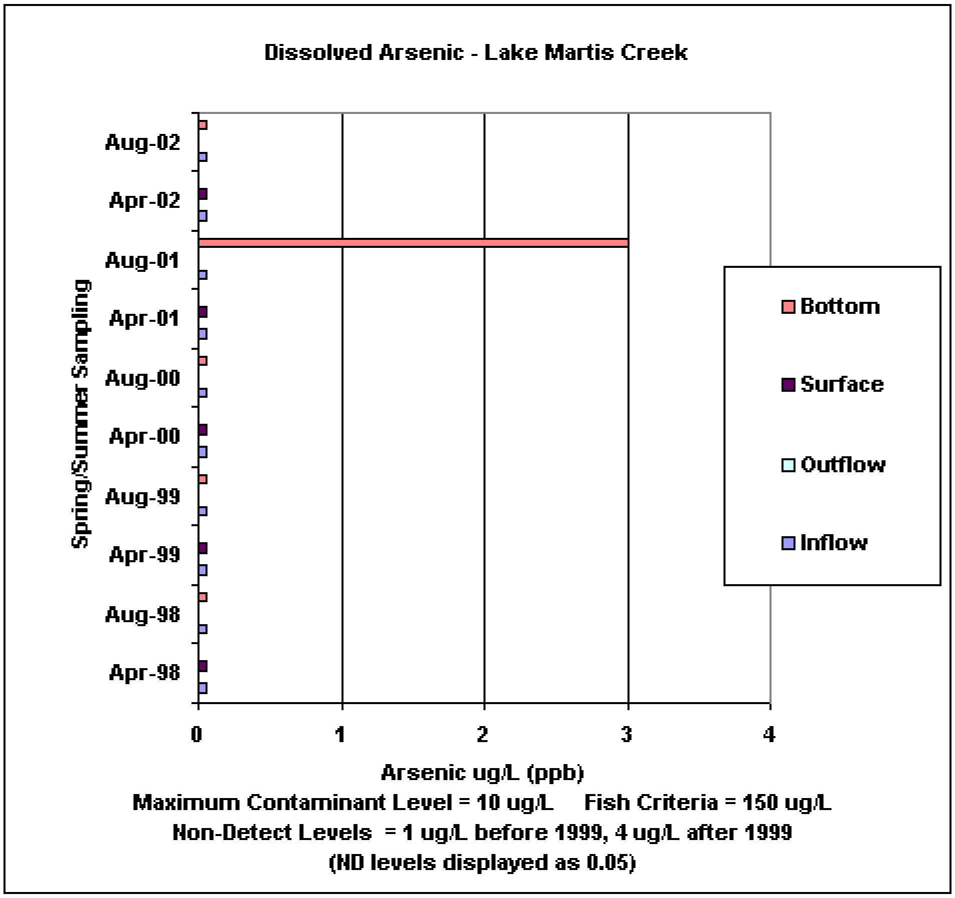
MARTIS CREEK					
Sample Location: Behind dam				**Date:** 4/25/02	
Observers: Tim McLaughlin				**Time:** 10:30 am	
Lake Elevation: 5480.29					
Weather Conditions:					
Wind Speed: 0		**Precipitation:** 0		**Temp (F):** 60	
SECCHI Depth: 5 feet and 10 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
5.1	19.7	7.38	84	8.26	7.54
4	13.1	8.88	87	10.27	7.81
2	6.6	11.13	91	9.74	7.88
0.03	1	11.83	90	10.25	7.91
MARTIS CREEK (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
47.7	7.61		-	-	-
VISUAL OBSERVATIONS: Some aquatic vegetation on surface.					

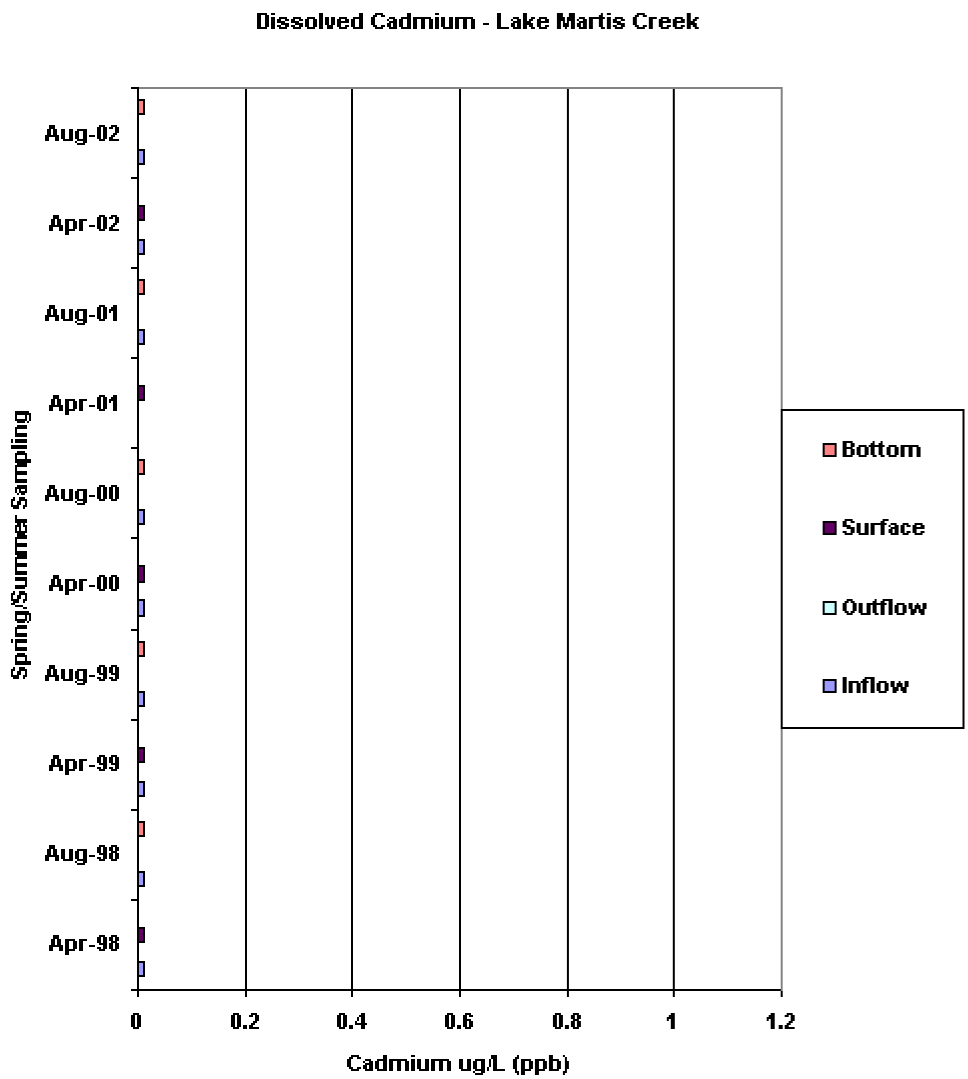
MARTIS CREEK					
Sample Location: Behind dam				**Date:** 8/08/02	
Observers: Tim McLaughlin				**Time:** 10:45 am	
Lake Elevation: 5780.02					
Weather Conditions:					
Wind Speed: 10		**Precipitation:** 0		**Temp (F):** 75	
SECCHI Depth: 9 feet and 6 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
4.5	19.7	18.34	138	7.11	9.12
4	13.1	18.43	138	7.19	9.81
2	6.6	18.7	137	7.18	9.84
0.03	1	19.18	137	3.54	8.33
MARTIS CREEK (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
67.2	9.16		-	-	-
VISUAL OBSERVATIONS: Some floating algae and aquatic vegetation.					

Appendix C: Phytoplankton Data and Charts

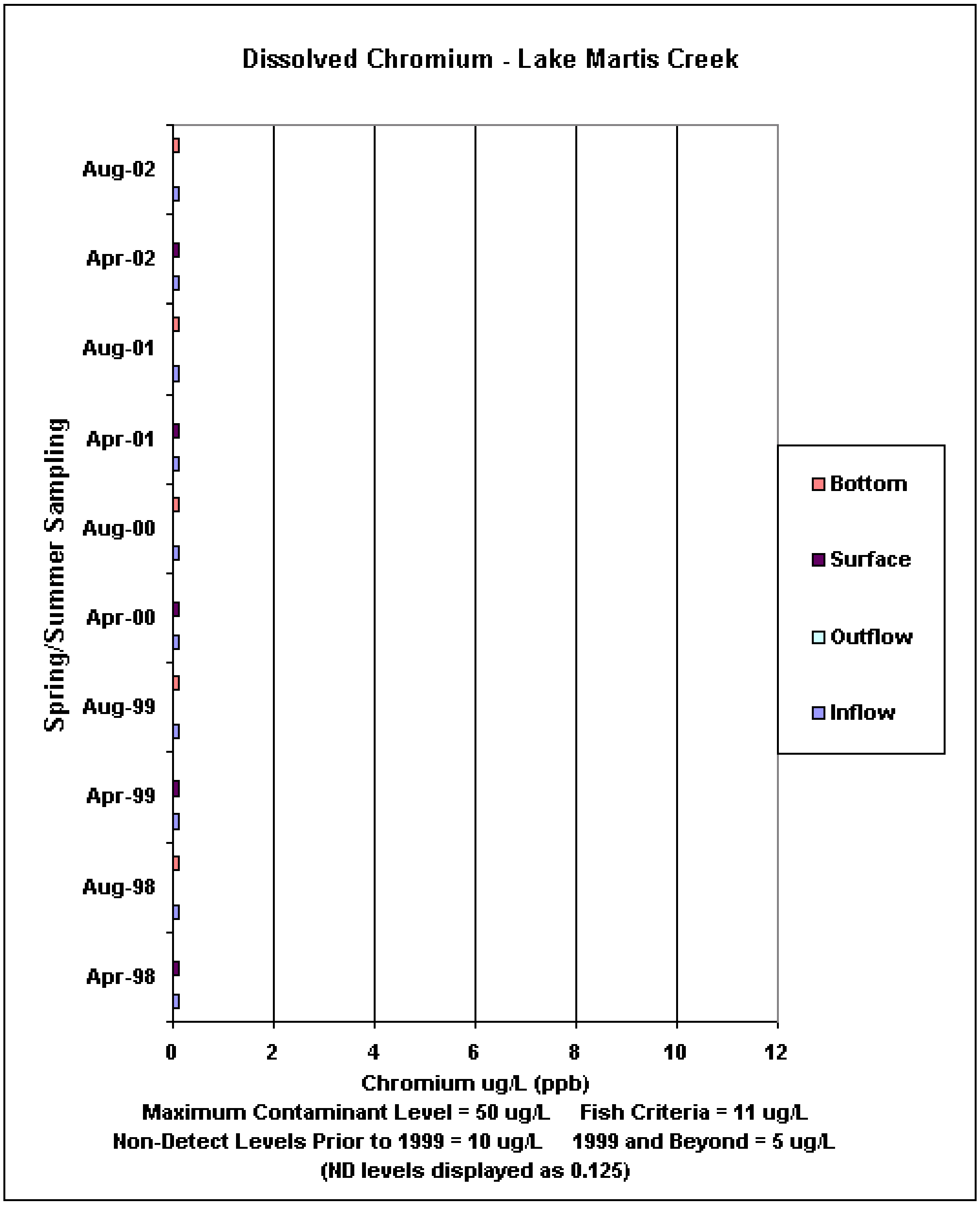

Phytoplankton Biomass 2002
Martis Lake
Biomass (µg/L)
7000
6000
5000
4000
3000
2000
1000
0
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
25-Apr-02
.
08-Aug-02

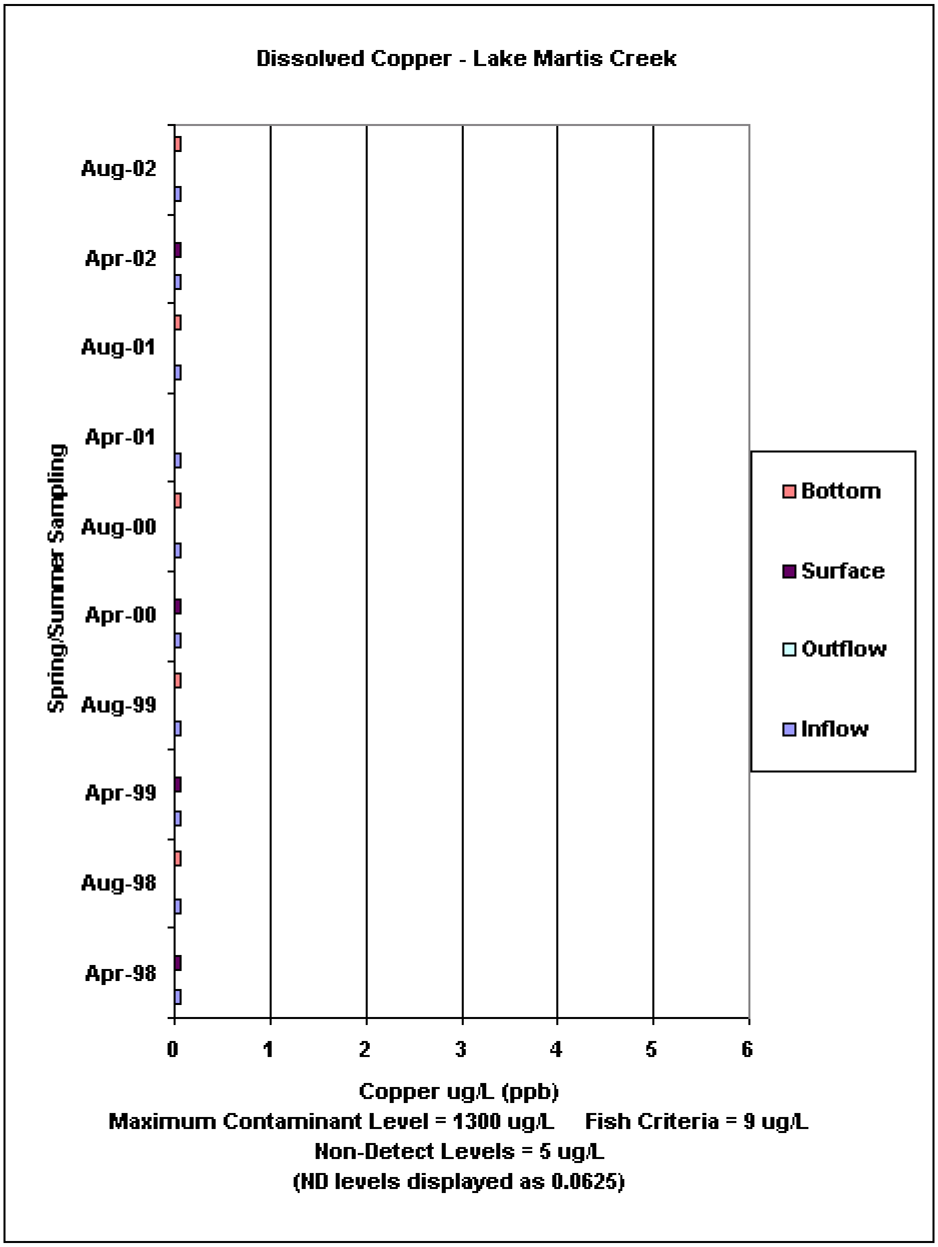
Appendix D: Metals Data and Charts

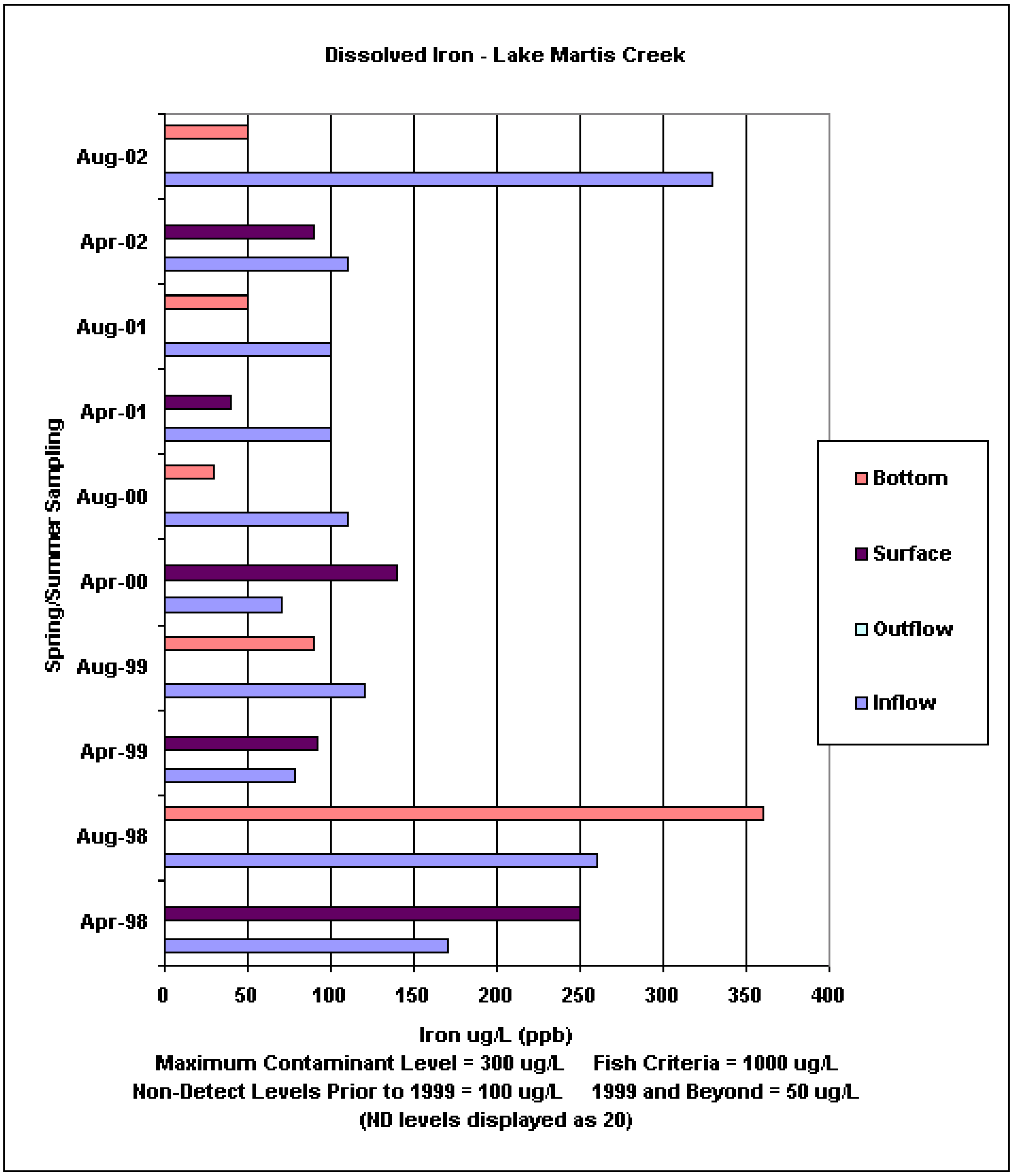

Dissolved Arsenic - Lake Martis Creek
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
1
2
3
4
Bottom
Surface
Outflow
Inflow
Arsenic ug/L (ppb)
Maximum Contaminant Level = 10 ug/L   Fish Criteria = 150 ug/L
Non-Detect Levels = 1 ug/L before 1999, 4 ug/L after 1999
(ND levels displayed as 0.05)



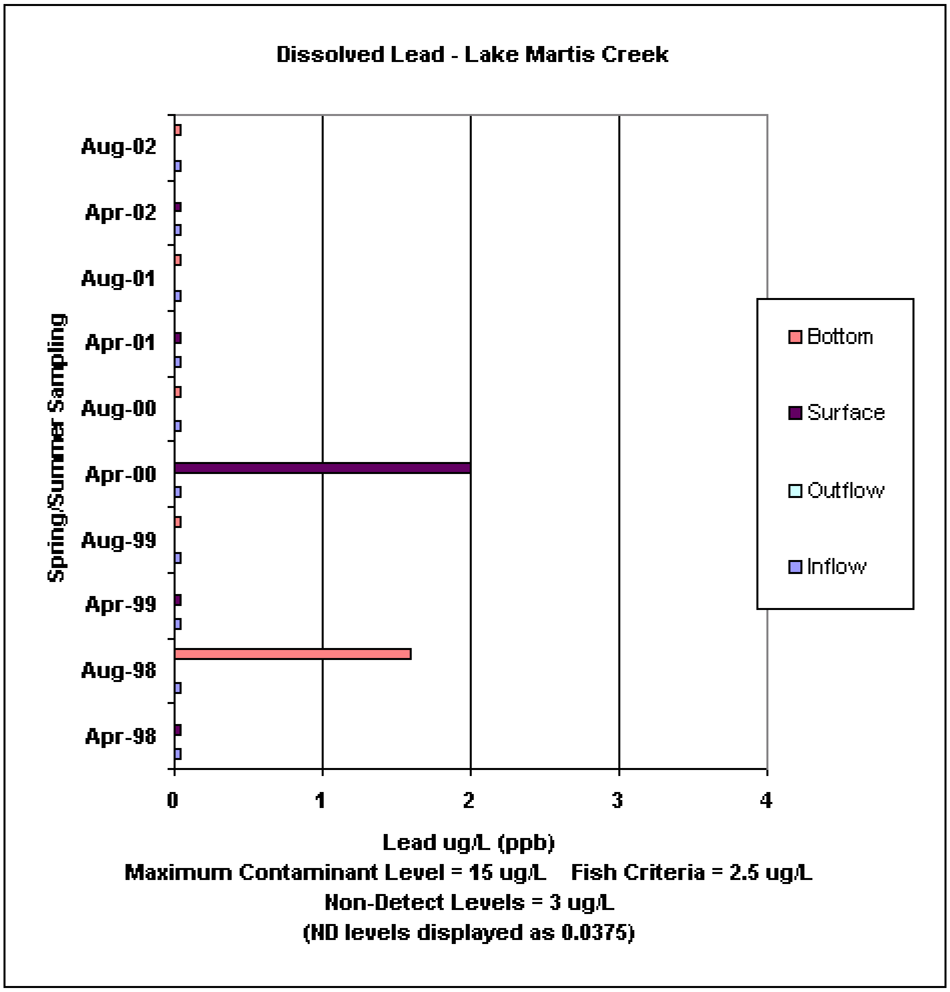
Maximum Contaminant Level = 5 ug/L   Fish Criteria = 2.2 ug/L
Non-Detect Levels Prior to 1999 = 0.5 ug/L   1999 and Beyond = 1 ug/L
(ND levels displayed as 0.0125)


Dissolved Chromium - Lake Martis Creek
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
10
12
Chromium ug/L (ppb)
Bottom
Surface
Outflow
Inflow
Maximum Contaminant Level = 50 ug/L   Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L   1999 and Beyond = 5 ug/L
(ND levels displayed as 0.125)

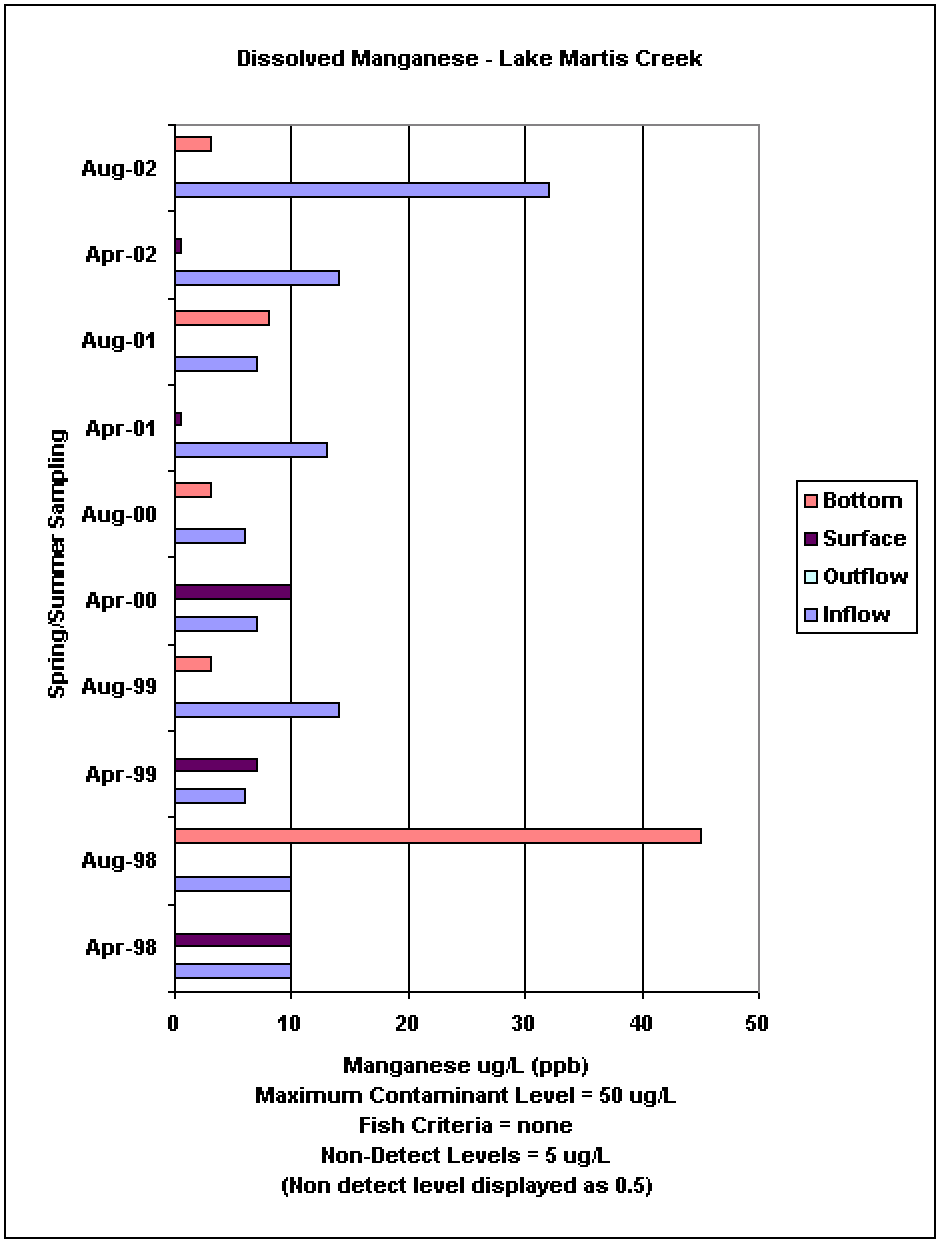

Dissolved Copper - Lake Martis Creek
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
5
6
Bottom
Surface
Outflow
Inflow
Copper ug/L (ppb)
Maximum Contaminant Level = 1300 ug/L Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L
(ND levels displayed as 0.0625)



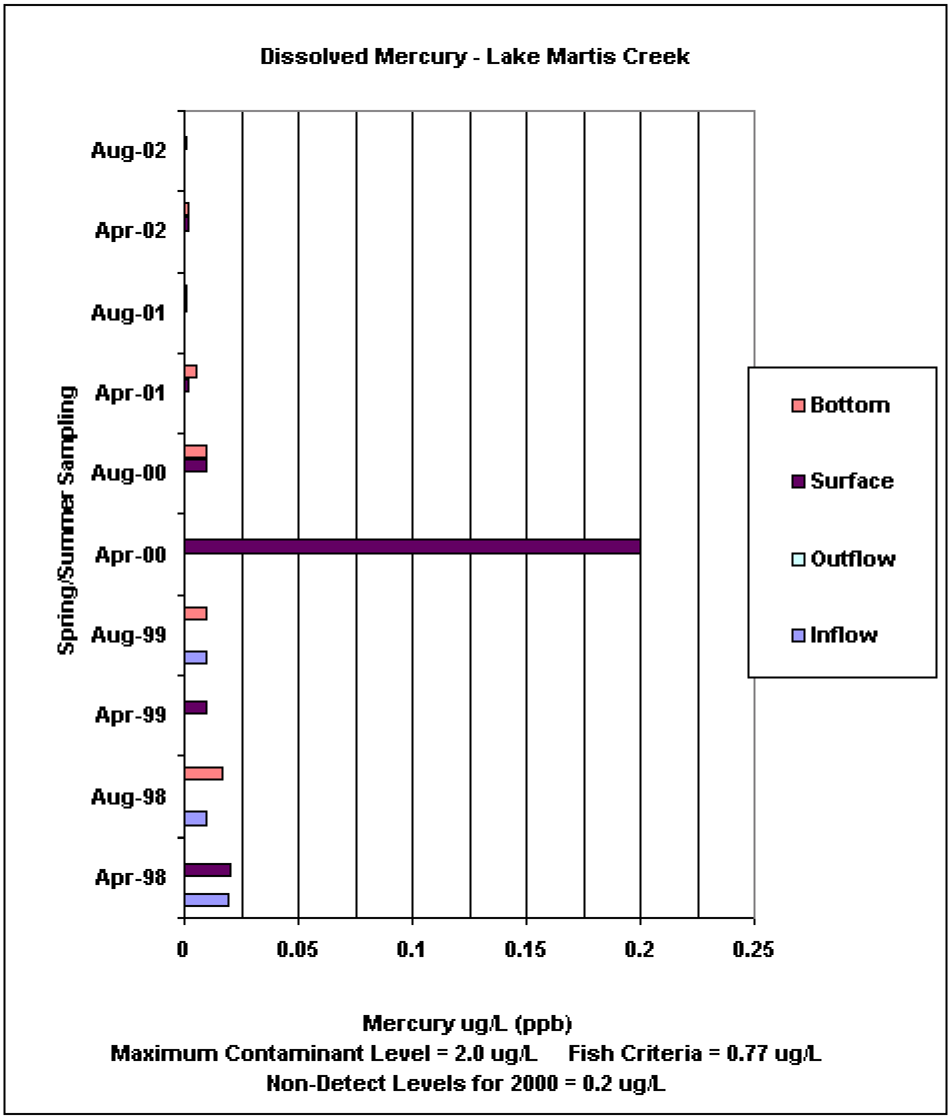
Dissolved Iron - Lake Martis Creek
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
50
100
150
200
250
300
350
400
Bottom
Surface
Outflow
Inflow
Iron ug/L (ppb)
Maximum Contaminant Level = 300 ug/L
Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L
1999 and Beyond = 50 ug/L
(ND levels displayed as 20)

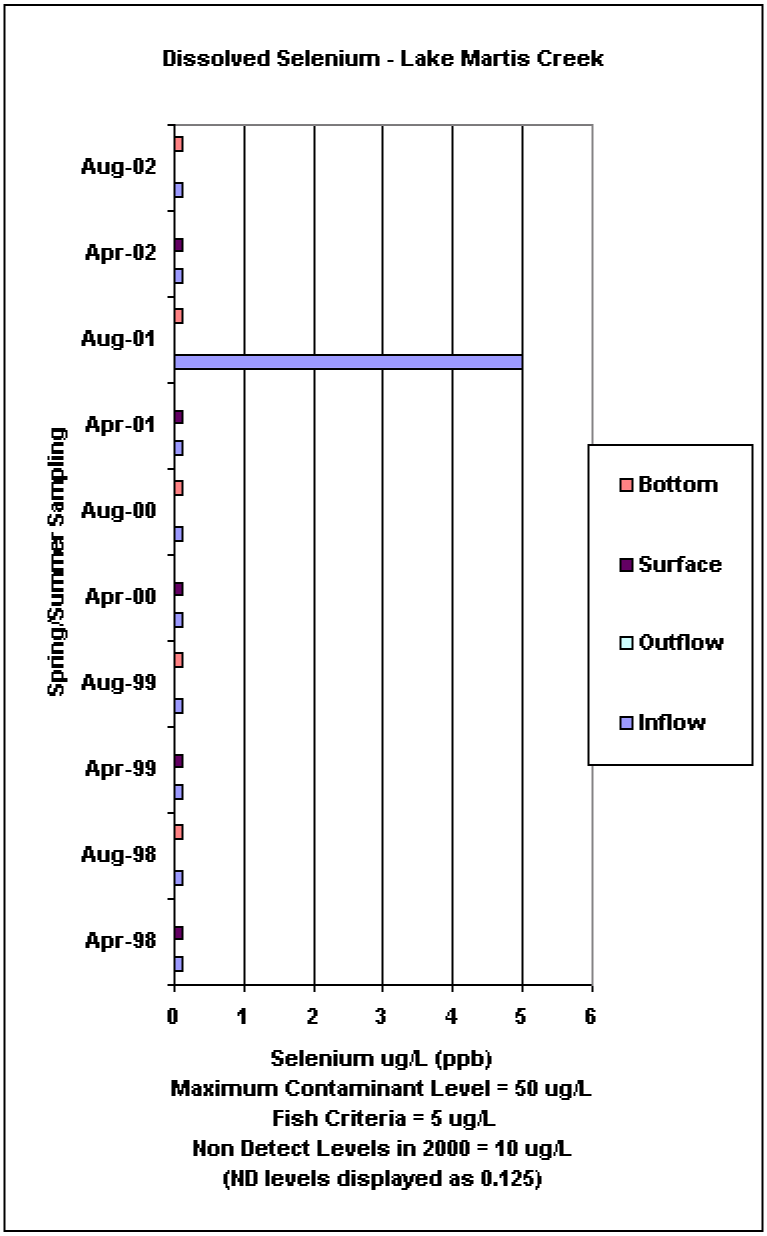


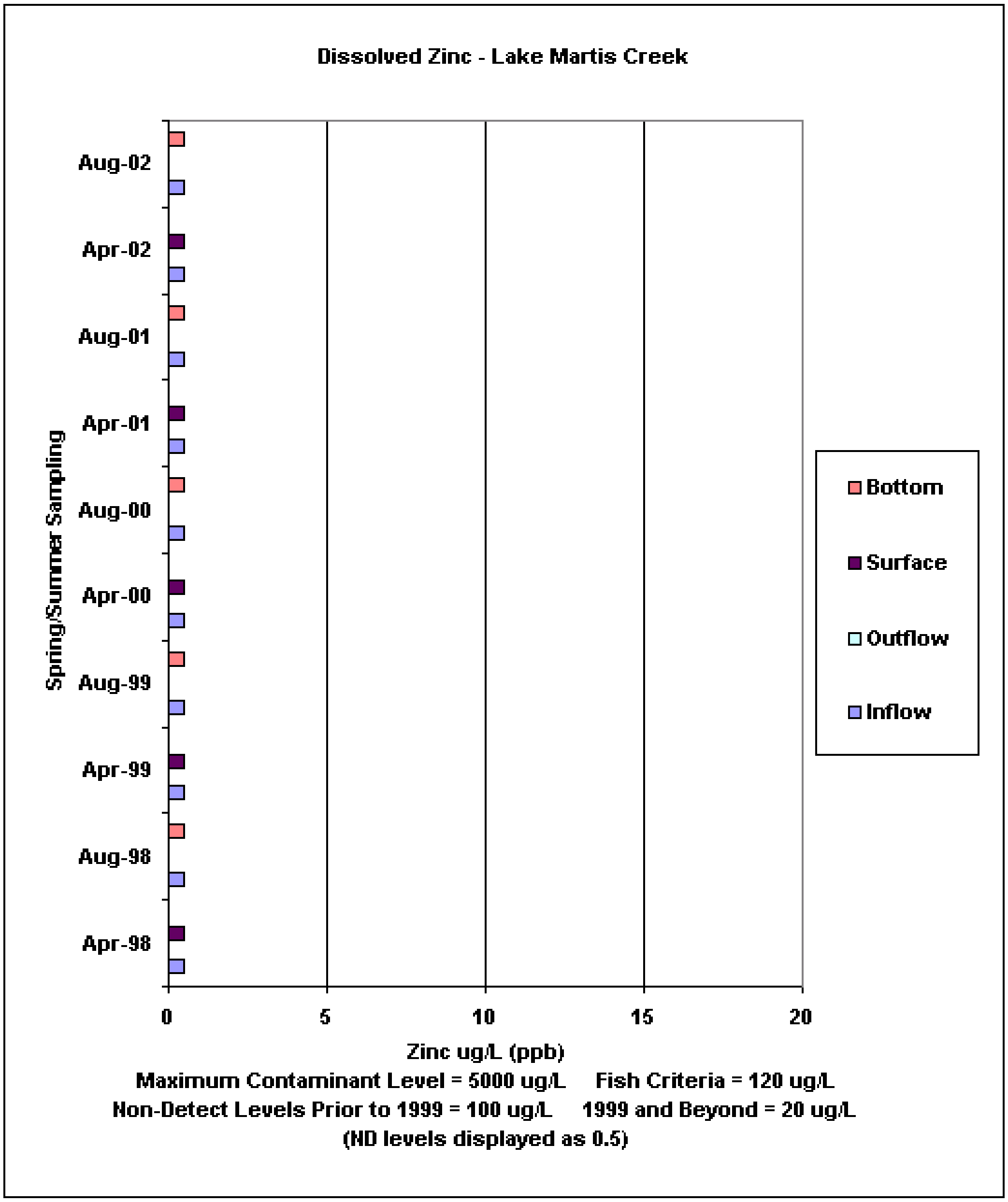
Dissolved Lead - Lake Martis Creek
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
1
2
3
4
Bottom
Surface
Outflow
Inflow
Lead ug/L (ppb)
Maximum Contaminant Level = 15 ug/L Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L
(ND levels displayed as 0.0375)



Dissolved Manganese - Lake Martis Creek
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
10
20
30
40
50
Bottom
Surface
Outflow
Inflow
Manganese ug/L (ppb)
Maximum Contaminant Level = 50 ug/L
Fish Criteria = none
Non-Detect Levels = 5 ug/L
(Non detect level displayed as 0.5)


Dissolved Mercury - Lake Martis Creek
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.05
0.1
0.15
0.2
0.25
Bottom
Surface
Outflow
Inflow
Mercury ug/L (ppb)
Maximum Contaminant Level = 2.0 ug/L Fish Criteria = 0.77 ug/L
Non-Detect Levels for 2000 = 0.2 ug/L


Dissolved Selenium - Lake Martis Creek
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
5
6
Bottom
Surface
Outflow
Inflow
Selenium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L
Fish Criteria = 5 ug/L
Non Detect Levels in 2000 = 10 ug/L
(ND levels displayed as 0.125)



Dissolved Zinc - Lake Martis Creek
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
5
10
15
20
Bottom
Surface
Outflow
Inflow
Zinc ug/L (ppb)
Maximum Contaminant Level = 5000 ug/L   Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L   1999 and Beyond = 20 ug/L
(ND levels displayed as 0.5)

Appendix E: Inorganic Sample Data

Inorganic Results (mg/L) For surface lake waters (spring)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity		60	40	50	60	30	40	70	80	20		100
Ammonia		<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Chloride		21	2	21	4	4	3	<1	6	5		4
Nitrate		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1		<0.1
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Sulfate		5.3	2.6	4.2	8.9	2	1	8.2	9	2.1		4.7
Kjeldahl N		0.6	0.1	0.4	0.2	<0.1	0.3	0.2	0.2	0.2		<0.1
COD					<50							
Tot Solids		120	70	100	110	60	78	100	120	21		150

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	100	70	40	50	20	30	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	13	25	3	21	<1	<1	4	<1	6	4	3	2
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	
Sulfate	18	2.1	2.3	3	2.8	1.9	0.8	8.8	11	1.6	11	3.5
Kjeldahl N	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1
COD	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	170	130	59	110	60	60	90	110	150	30	130	90

Inorganic Results (mg/L) For surface lake waters (summer)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	140	70	40	50	50	40	70	90	80	10	80	110
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
Chloride	16	26	4	19	6	5	5	5	9	3	5	8
Nitrate	<0.1	1.5	<0.1	1.3	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1
Total P	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	16	4.1	3.6	3.5	5.9	2	0.7	7.4	14	1.6	6.4	4.4
Kjeldahl N	<0.1	2.7	<0.1	0.4	0.4	0.3	<0.1	0.2	<0.1	<0.1	0.2	0.6
COD	<50	60	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	200	190	50	120	98	80	80	120	120	52	100	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	90	40		60	40	80	100	130	20	110	180
Ammonia												
Chloride	16	490	5		10	8	3	5	14	4	5	22
Nitrate												
Total P												
Ortho P												
Sulfate	16	4.5	3		9.8	3.2	<0.5	6	14	2.7	5.4	8.7
Kjeldahl N												
COD												
Tot Solids	200	1300	50		140	100	100	150	200	50	140	280

Appendix F: MTBE Table

2002 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2002 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	2		2		<2		<2		
Eastman	5				<2				
Englebright	3		3		10		10	10	
Hensley	3		3		3		3		
Isabella	<2	<2	<2	<2	<2	<2	<2	<2	
Kaweah	2		2	<2	8		6	6	
Martis Cr.	<2				<2				
Mendocino	<2				<2				
New Hogan	<2				3				
Pine Flat	<2		<2		2		2		
Sonoma		3	<2		<2		2		
Success	4		4	4	11	12	11	11	

Notes:

1. Non-Detect is indicated by "<2" since the Reporting Limit is 2 ppb or 0.002 ppm.

2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.

3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.

4. For 2002, the number of MTBE water sampling at each lake is based on last year's lab results.

5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was historically non-detectable. The 2002 results of non-detectable levels were similar except Lake Eastman and New Hogan now reported low, detectable levels of MTBE.

6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because of historically low detectable levels of MTBE.

7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because of historically higher MTBE being found. The 2002 results were similar except Isabella now reported non-detectible levels.

8. In 2001, very high MTBE levels were reported at Lake Isabella during the Spring (18 ug/L near the marina) . During Spring 2000, Lake Isabella reported 21 ug/L. The 2002 results indicate that the previous MTBE problem near the marina was not visible during the Spring 2002 sampling event, and may have been rectified.

Appendix G: Fish tissue analysis table

2002 Fish Tissue Results

The following table provides an overview of the lab results for the 2002 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conducting the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The California OEHHA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Mercury Total ppm	FDA Criteria
Black Butte	Sm M Bass	Composite (3)	6/12/02	0.24	0.26	1 ppm
Eastman	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Englebright	Note 5	N/A	N/A	N/A	N/A	
Hensley	Black Bass	Composite (3)	4/23/02	<0.10	0.72	1 ppm
Isabella	Black Bass	Composite (3)	6/4/02	0.20	0.21	1 ppm
Kaweah	Sm M Bass	Composite (3)	7/14/02	0.11	0.53	1 ppm
Martis Cr	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Mendocino	Note 6	N/A	N/A	N/A	N/A	
New Hogan	Lg M Bass	Single (1)	6/3/02	<0.10	0.34	1 ppm
Pine Flat	Note 4	--------------------	-----------	----------	-----------	< Mon 01
Sonoma	Note 6	N/A	N/A	N/A	N/A	
Success	Black Bass	Composite (3)	4/15/02	<0.10	0.18	1 ppm

Notes:

9. Non-Detect is indicated by "<0.02". The lab Detection Limit for mercury is 0.02 ppm.
10. Total Mercury was reported in mg/g or ppm.
11. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.
12. The fish tissue program was terminated at Eastman and Martis Creek in 2001 and in Pine Flat in 2002 due to low total mercury results. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout). For Pine Flat total mercury was 0.21 ppm in 2000 (composite of three Sacramento Sucker fish) and 0.23 in 2001 (composite of three spotted bass).
13. Due to seasonal conditions, a fish could not be successfully collected at Lake Englebright. Another attempt will be accomplished for the 2003 report.
14. Fish were not collected at Mendocino or Sonoma due to communication difficulties.

The above 2002 total mercury results indicate only Hensley is higher than average. However, in 2001, the total mercury results were only 0.30 ppm for Hensley (small mouth bass). The 2003 fish tissue program should provide additional data. EPA fact sheet on fish advisories (EPA-823-F-99-016) indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.

Annual Water Quality Report

LAKE MENDOCINO

Water Year 2002

Written by
John J. Baum
Water Quality Engineer
U. S. Army Corps of Engineers
Sacramento District
January 2003

TABLE OF CONTENTS

Lake Mendocino

I. Purpose

This report is part of an environmental monitoring program that restarted at Lake Mendocino in April 1983. The monitoring program was implemented to determine the level of water quality in the lake for both recreation and environmental health and to satisfy the Department of Army Engineering Regulation 1110-2-8154, “Water Quality and Environmental Management for Corps Civil Works Projects”.

II. Brief Description of Lake Mendocino

Lake Mendocino is located in the northern coast range of California, two miles northeast of Ukiah, California. The lake was created by the completion of Coyote Dam on the East Fork of the Russian River in 1958. At capacity the lake has 1,822 surface acres and is held in place by a dam that is 160 feet high and 3,500 feet long. The structure provides flood damage reduction, water conservation, and hydroelectric power. Since being built for flood control and irrigation, the lake has also become a popular destination for recreation.

Generally there are two sample events a year, spring (April) and late summer (August). Since the start of the monitoring program, a water quality report is produced yearly to list results and address any concerns of the previous water year.

Generally, Lake Mendocino has a depth of less than 100 feet during the sampling events and is considered a mesotrophic lake when characterized by its clarity. A mesotrophic lake is one that has physical qualities in between an oligotrophic (clear and nutrient limited, example Lake Tahoe) and a eutrophic lake (low clarity and high in nutrients, example Clear Lake). Like several eutrophic lakes that are monitored by the USACE, Lake Mendocino cannot maintain dissolved oxygen in its bottom waters during warm late summer months. Lake Mendocino is warm (>20ºC) in the late summer. Due to both the warm temperatures and low dissolved oxygen concentrations in the lake during the late summer, coldwater fish species would have difficulties breeding and surviving in the lake year round. Although clearer than eutrophic (nutrient rich) lakes, mesotrophic lakes can have low water clarity due to algal blooms. Additionally sediments suspended by wind action also decrease clarity. Water clarity is often measured in terms of Secchi Disc depth or SD (Appendix A). Historically, the water clarity in Lake Mendocino is very good with only ~2.6 % of the samples not meeting the recreational goal of 4 feet or greater (Figure 1). In 2001 the Spring SD measure was 11.58 feet and the late summer sample event had a SD of 9.67 feet.

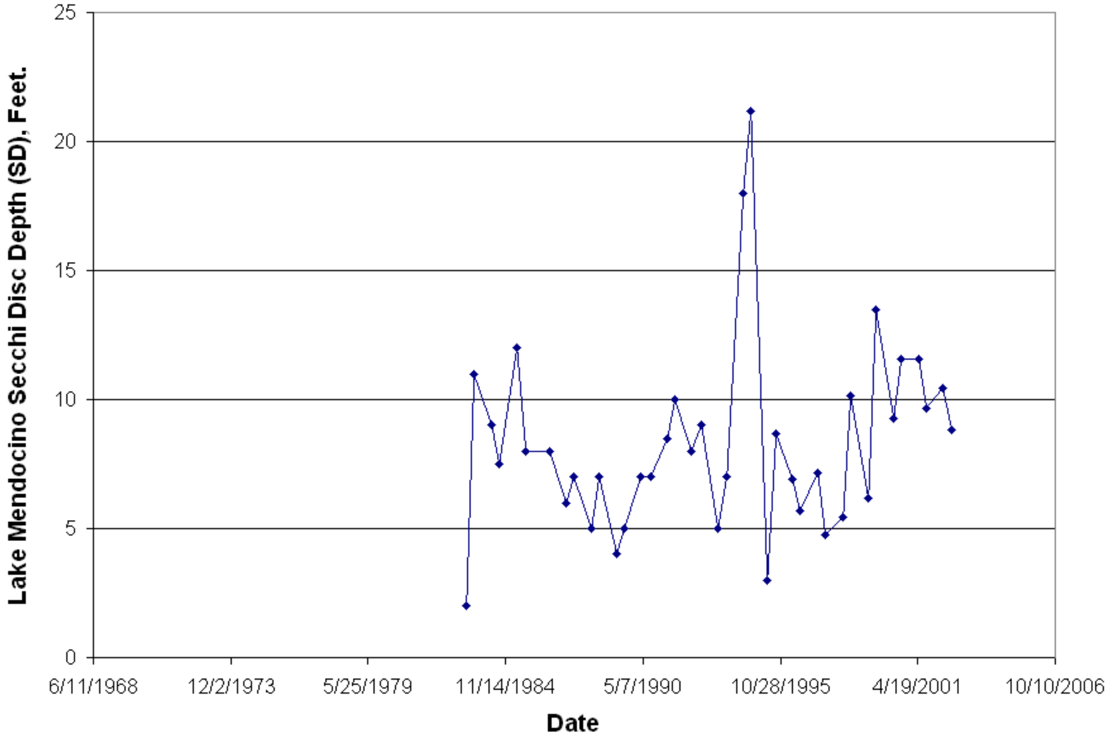


Figure 1. Historical Secchi Depth Values at Lake Mendocino (2002 values included).

The 2001 Water Quality Report listed no contaminants of concern at Lake Mendocino.

III. Sample Summaries for this year.

Introduction

The following general summaries are split into their respective sample types. Each type of sample summary includes a discussion of both the spring (April) and late summer (August) samples to better examine trends within the current year. The types of parameters monitored this year include: Secchi Disc depths, water column profiles (temperature, DO and pH), phytoplankton characterization, metals concentrations, MTBE concentrations, and Inorganic characterization (alkalinity, phosphorous, nitrogen, etc..). Fish mercury sampling was not performed in 2002 due to coordination difficulties. Fish tissue mercury concentration for water year 2001 resulted in a value of 0.34 ppm in a composite sample of three large mouth bass. Fish sampling will resume in 2003. For a more detailed explanation of the importance of each type of sample, please see Appendix A.

SECCHI DEPTH

The Secchi Disc depths found during the spring and late summer sampling events were higher than the historical average (historical mean SD = 8.3 feet). More often the clarity is better in the late summer than in the late spring, but sometimes the spring sampling event is clearer. At the spring sampling event the water clarity was high (Spring 2002 SD = 10.42 feet), but it was worse than the previous year (2001 Spring SD = 11.58 feet). The late summer SD of 8.83 feet was above the recreational goal of 4 feet but less than the previous year (Summer 2001 SD = 9.67) (Appendix B).

TEMPERATURE VALUES

The temperature profiles for Lake Mendocino are indicative of a seasonally mixed lake. The lake is stratified in the spring, but this disappears because of the warm temperatures of late summer. There is a considerable depth difference between the spring and late summer sampling events (spring depth = 97.9 feet, late summer depth= 59.1 feet). Additionally, the average temperatures were very different (spring average temp. = 11.37 ºC, late summer average temp.= 23.39 ºC). Lake Mendocino's temperature varies due to there not being a cooler deep-water area throughout the year to buffer it from the warm summer air temperatures. It is unlikely that Lake Mendocino would be able to support coldwater fish species. For detailed results obtained during the sampling events, please see Appendix B.

DISSOLVED OXYGEN

The dissolved oxygen (DO) concentration differs greatly from spring to late summer. In the spring DO concentrations are 9.32 mg/L near the surface and 8.16 mg/L at the bottom of the lake. DO concentrations at the water surface are near saturation, which is 9.76mg/L at 16.5 º C. DO concentrations in the late summer were highest near the surface (DO = 3.55 mg/l) and was lowest near the bottom of the lake (DO =1.33mg/l). Fish species that require greater than 5 mg/l DO at cooler water temperatures (< 20ºC) would have difficulty surviving year round in Lake Mendocino. For detailed results obtained during the sampling events, please see Appendix B.

pH.

In the spring and late summer sampling events, pH values in the lake were slightly basic throughout the water column. In the spring sampling event the highest pH was near the surface (Spring 2002 surface pH ~ 7.9) and the lowest was at the bottom (Spring 2002 bottom pH = 7.49) The pH values in the late summer profile varied widely and were slightly less basic. The pH was most basic towards the middle waters (Late Summer 2002 max pH = 7.94) and slightly less basic bottom (Late summer 2002 pH bottom = 7.25). For detailed results obtained during the sampling events, please see Appendix B.

PHYTOPLANKTON

In the spring sample, the algal biomass within the lake was high (Biomass = 630.89 µg/L) compared to spring 2001 (2001 Spring biomass = 178.16 µg/L). In spring 2001 and 2002 diatoms were the most dominant species. In late summer a similar trend occurred. The phytoplankton population was much higher in summer 2002 (2002 Summer Biomass = 1,867.65 µg/L) than summer 2001 (2001 Summer Biomass = 795.20 µg/L). Dinoflagellates were the most dominant species during the 2002 late summer sampling event, but diatoms dominated in summer 2001. For detailed results obtained during the 2002 sampling events, please see Appendix C.

METALS

None of the dissolved heavy metal samples exceeded the maximum contaminant level (MCL) or the freshwater fishery criteria during the 2002 spring and summer sampling events. Contaminants will continue to be monitored in the coming year for any changes. For detailed results obtained during the sampling events, please see Appendix D.

MTBE

Concentrations for MTBE around the lake were found to be below the detection limit (< 2 ppb) during both spring and late summer sampling events. For detailed results obtained during the sampling events, please see Appendix F.

INORGANIC ANALYSIS

The spring and summer sample results were within expected ranges and levels. For detailed results obtained during the 2002 sampling events, please see Appendix E.

IV. Conclusions

Lake Mendocino is a mesotrophic lake that can support warmwater fish species. Coldwater fish that require temperatures below 20°C and dissolved oxygen concentrations greater than 5 mg/L will probably be unable to breed and survive late summer conditions at Lake Mendocino.

In the 2002, Lake Mendocino sampling results indicated that there were no contaminants of concern. An area that requires improvement is the coordination of fish sampling so that more data will be available for the 2003 water quality report.

V. References

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VI. Appendices

Appendix A: Glossary of Sample Types

Glossary of Sample Types

This glossary of sample types is intended to provide a general background and indicate the importance of each sample in determining water quality. These are meant to be brief and basic. If a further explanation is desired please refer to the list of references provided in this report.

Secchi Depth

One of the oldest and easiest methods to determine lake clarity is the Secchi depth (SD). The Secchi depth is determined by dropping a Secchi disc into a water body and determining the depth that it is last visible from the surface of the water. Secchi discs are generally white and 20 cm in diameter. Secchi depth values are most impacted by the light intensity at the time of sampling and the scattering of light by solid particulates within the water column. Algal growth (phytoplankton) and sediment re-suspension are often major constituents of solid particulates within the water column. Secchi depth values can be used to estimate the Trophic state or the nutrient levels within the lake. The more nutrients are available, the larger likelihood of algal blooms that limit water clarity. Due to recreational concerns for safety, the goal for Secchi depth values is four feet or greater.

Temperature Profiles and Data Points

The temperature profile of a lake provides information how a lake is operating and the potential for aquatic biota to live within the lake. The temperature profile is a direct indicator if a lake is stratified. Stratification in lakes is created generally by temperature affecting the density of water molecules. Stratification is usually indicated by a region of similar temperature nearer the surface of the water (epilimnion), then a region of temperature transition (metalimnion), to another layer of nearly constant temperature at the bottom of the lake (hypolimnion). Each layer in a stratified lake is important, but the existence of a hypolimnion can drastically impact how well a lake can handle warmer temperatures such as those found in northern California during the summer. The hypolimnion acts as a buffer against large temperature shifts. The nature of dam operation is that water is discharged near the bottom, releasing the hypolimnion, and eliminating stratification. This operation limits the ability of reservoirs to regulate their temperature during the summer months. Stratification isn't always desirable. When a lake isn't stratified and is instead well mixed, the required nutrients near the bottom of the lake become available to phytoplankton for growth. Temperatures within lakes also indicate which species of fish will survive within a lake. Coldwater species of fish require temperatures below 20 degrees C in order to spawn and survive. If a lake is often above 20 degrees C, then only warmwater fish species will survive.

Dissolved Oxygen (DO) Concentration Profiles

DO is required by organisms for respiration and for chemical reactions within lake waters. The recommended level for DO for most aquatic species survival is 5mg/L. In lakes, biota waste (detritus) falls to the bottom of the lake to be utilized by bacteria. The

bacteria need oxygen and will deplete levels near the bottom of a lake, especially during warm temperature, high respiration conditions. For nutrient rich (eutrophic) lakes more organisms will grow, create wastes, and cause oxygen depleted regions at the lowest areas. Under these conditions only aquatic species that can survive low DO conditions in warm water near the surface will survive.

PH Profiles

The pH profiles of the lakes indicate the potential for certain chemical reactions to occur. In high pH (greater than pH = 7 or basic) aquatic systems, metal pollutants tend to form into insoluble compounds that fall onto the lake floor. In low pH (less than pH = 7 or acidic) systems or areas metal ions become soluble and available for uptake into aquatic organisms. Other compounds like ammonia that are introduced into a low pH aquatic environment will transform into soluble nitrate and be utilized by organisms.

Phytoplankton Analysis

Phytoplankton analysis indicates the health, nutrients, and biodiversity within a lake. Lakes that have few nutrients available (Oligotrophic) will generally have a much lower quantity of phytoplankton (high Secchi depth) but the number of phytoplankton species seen will be large. In a lake that is nutrient rich (eutrophic) there are generally large phytoplankton blooms (low Secchi depth), but they are made up of a couple of phytoplankton species. Certain species of phytoplankton are preferred food sources for zooplankton (small invertebrates). Generally species like diatoms and green algae can be consumed by the filter-feeding zooplankton, but species like bluegreen algae are low in nutrients and are difficult to consume. Some species like the dinoflagellates can grow horn like points to discourage potential predators. In nutrient rich waters where there is plenty of phosphorous, nitrogen can be limited for biological growth. While most species can't grow due to the lack of nitrogen, bluegreen algae (cyanobacteria) have the ability to utilize nitrogen from the atmosphere when required. This gives bluegreen algae the ability to dominate in many eutrophic lakes.

Soluble Metals Analysis

The soluble metals analysis indicates the exposure of humans and aquatic organisms to toxic metals. These metals often build up as they are consumed through the food chain. Water samples provide an indicator for additional problems. Soluble forms of metal ions are more prevalent in low pH (pH <7, or acidic) environments.

MTBE Analysis

MTBE (methyl tertiary-butyl ether) is a chemical additive to gasoline to improve combustion. Due to its high solubility, MTBE travels and blends into aquatic systems rapidly. While not found to be extremely hazardous at low levels, the offensive smell and taste is detectible by humans at extremely low concentrations. The effect of MTBE on humans and aquatic systems is still under investigation.

Inorganic Analysis

Alkalinity

Alkalinity is measured in terms of mg/L of calcium carbonate. It indicates a lakes ability to buffer incoming acidic pollution and situational changes.

Ammonia

Ammonia is a gas that is toxic to fish and is more visible at a higher pH. Ammonia is created through anthropogenic inputs, bacteria cell respiration, and the decomposition of dead cells. Due to being a gas, given time ammonia will volatilize from the water. At a lower pH, much of the ammonia is converted to ammonium (a nutrient for root bound plant life) and utilizes DO in the nitrification process.

Chloride

The chloride ion is an indicator of any salinity increases within a lake. Most fresh water aquatic species are sensitive to salinity changes.

Nitrate

Nitrate is the nitrogen product created through the nitrification of ammonium. Nitrate is a soluble form of the nutrient nitrogen and is utilized by phytoplankton.

Total Phosphorous

The total phosphorous provides a measure of both utilized and soluble phosphorous within water samples. Phosphorous is a required nutrient for plant growth and development.

Ortho Phosphorous

Ortho phosphorous is the soluble form of phosphorous that is utilized by free-floating aquatic plants (phytoplankton).

Kjeldahl N

Kjeldahl nitrogen or total Kjeldahl nitrogen (TKN) is a measure of the total concentration of nitrogen in a sample. This includes ammonia, ammonium, nitrite, nitrate, nitrogen gas, and nitrogen contained within organisms.

COD

Chemical Oxygen Demand (COD) is a measure of the total oxygen required to complete the chemical and biological demands of a sample.

Fish Tissue Analysis

Fish tissue is analyzed to examine potential exposure of humans to toxicants as well as the health of the aquatic food chain. In aquatic systems toxic contaminants can build up (or bioaccumulate) within animals at the top of the food chain. Contaminants (especially organic pollutants) are retained within the fat tissue of an organism, therefore in fish samples the lipid content is often measured.

Lake Code Designation

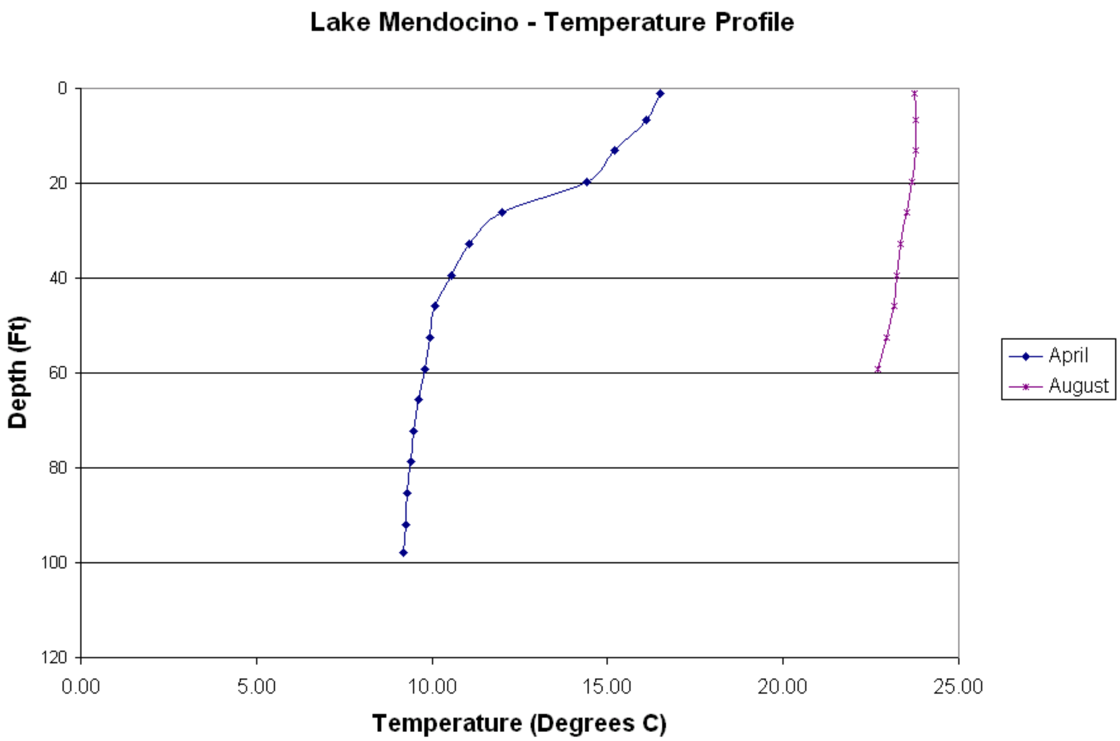
Laboratory Reports are provided in the previous sections.

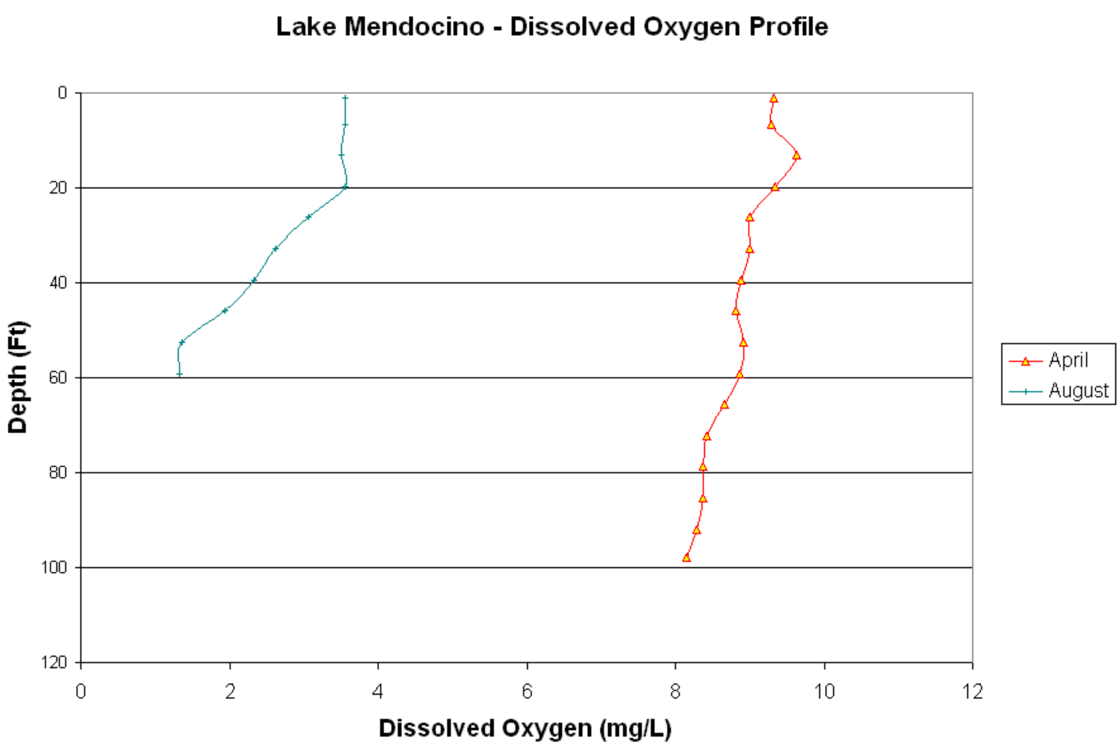
Sample ID is "XX-YY-ZZ" where

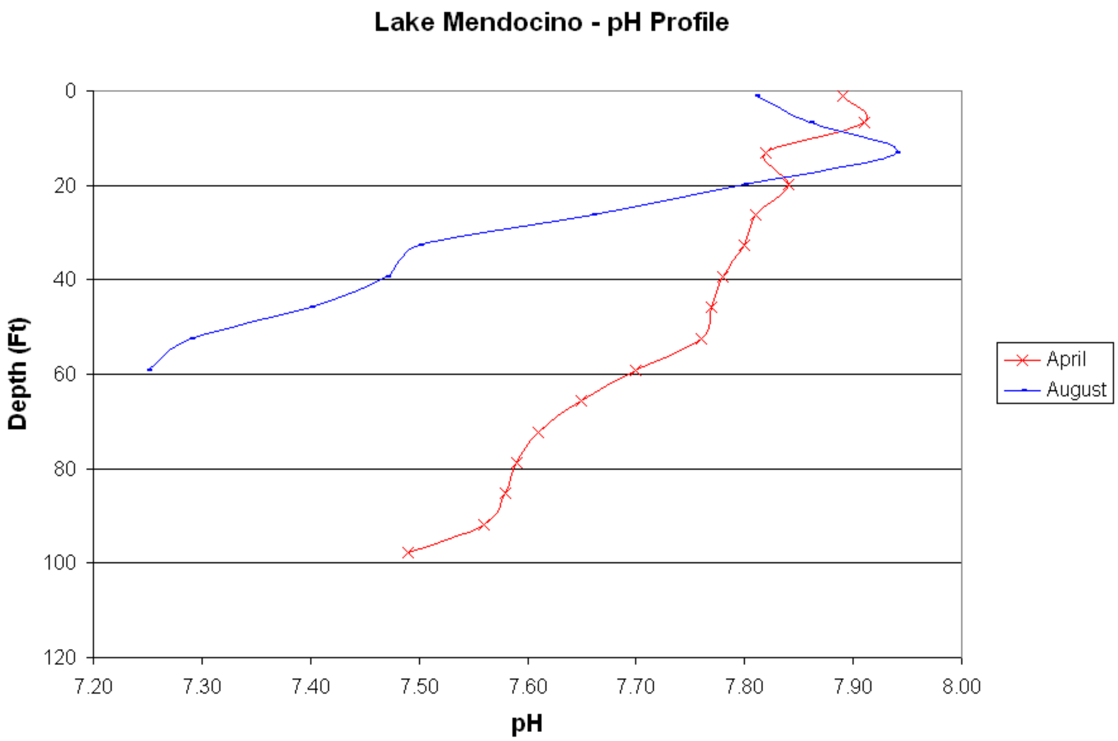
XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summar	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

Example: BB-SU-S is for a water sample taken from Black Butte in the Summer on the Lake's Surface.

Appendix B: Profile Data and Charts (Secchi Disc, Temperature, DO, and pH)


Lake Mendocino - Temperature Profile
Depth (Ft)
0
20
40
60
80
100
120
0.00
5.00
10.00
15.00
20.00
25.00
Temperature (Degrees C)
April
August


Lake Mendocino - Dissolved Oxygen Profile
Depth (Ft)
0
20
40
60
80
100
120
0
2
4
6
8
10
12
Dissolved Oxygen (mg/L)
April
August

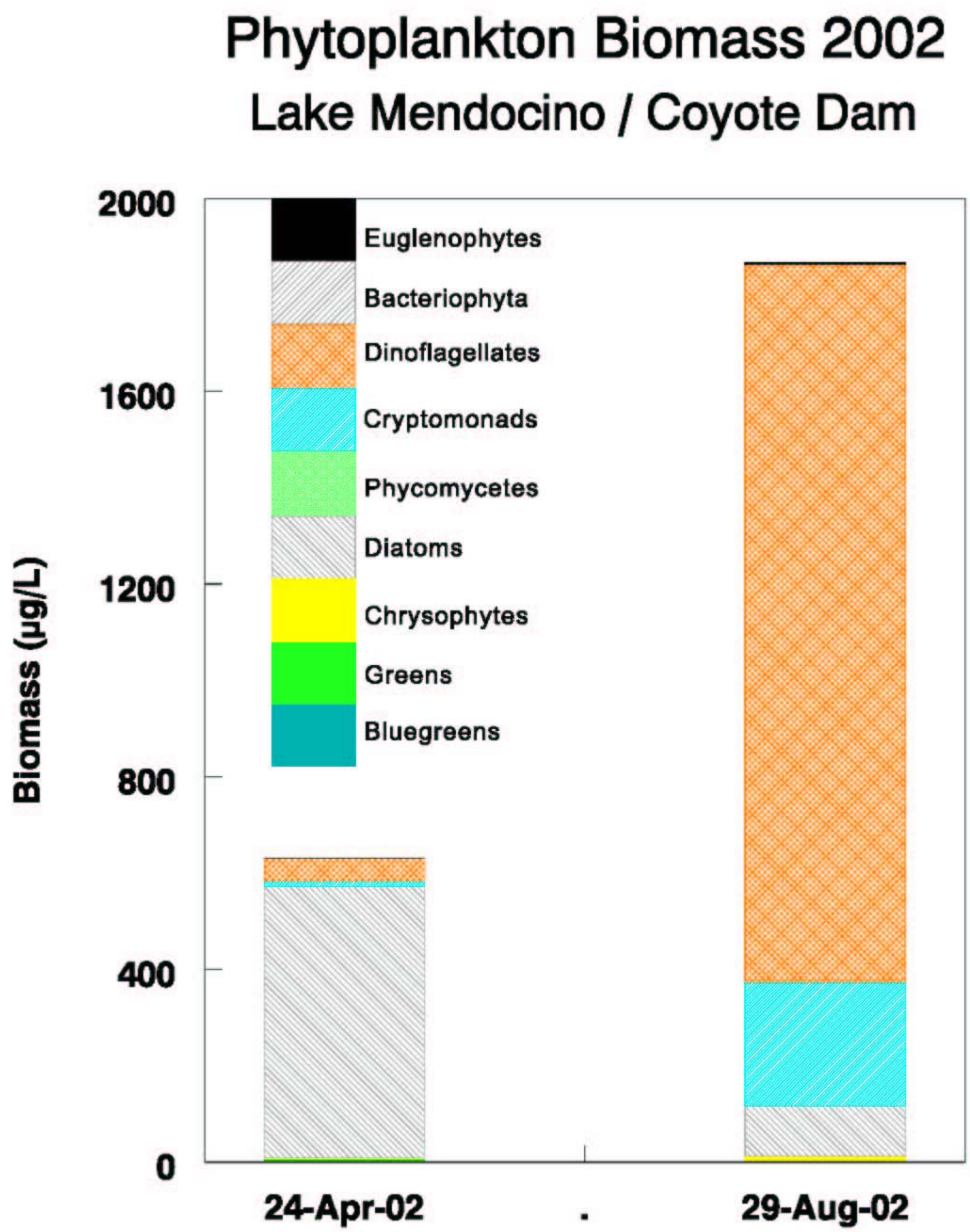


Lake Mendocino - pH Profile
0
20
40
60
80
100
120
Depth (Ft)
7.20
7.30
7.40
7.50
7.60
7.70
7.80
7.90
8.00
pH
April
August

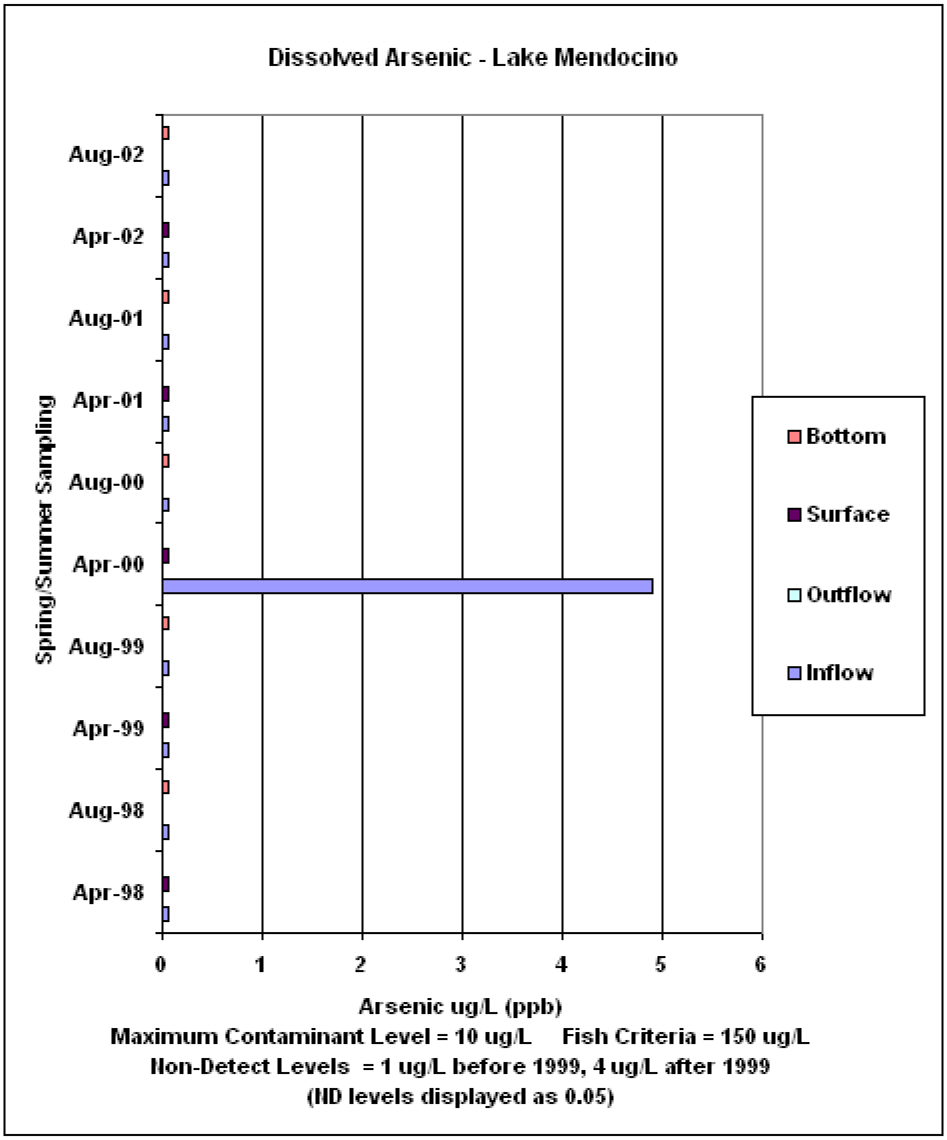
LAKE MENDOCINO					
Sample Location: Behind dam				**Date:** 4/24/02	
Observers: Tim McLaughlin				**Time:** 9:40 am	
Lake Elevation: 747.81					
Weather Conditions:					
Wind Speed: 10		**Precipitation:** 0		**Temp (F):** 60	
SECCHI Depth: 10 feet and 5 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
30	97.9	9.18	121	8.16	7.49
28	91.9	9.26	121	8.29	7.56
26	85.3	9.31	121	8.37	7.58
24	78.7	9.39	121	8.38	7.59
22	72.2	9.48	121	8.42	7.61
20	65.6	9.61	121	8.66	7.65
18	59.1	9.80	121	8.86	7.70
16	52.5	9.95	121	8.92	7.76
14	45.9	10.10	121	8.81	7.77
12	39.4	10.57	121	8.88	7.78
10	32.8	11.05	121	9.00	7.80
8	26.2	11.99	120	9.01	7.81
6	19.7	14.40	126	9.34	7.84
4	13.1	15.20	126	9.63	7.82
2	6.6	16.10	126	9.29	7.91
0.03	1	16.50	126	9.32	7.89
EAST FORK RUSSIAN (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
65.1	7.35		-	-	-
VISUAL OBSERVATIONS:					

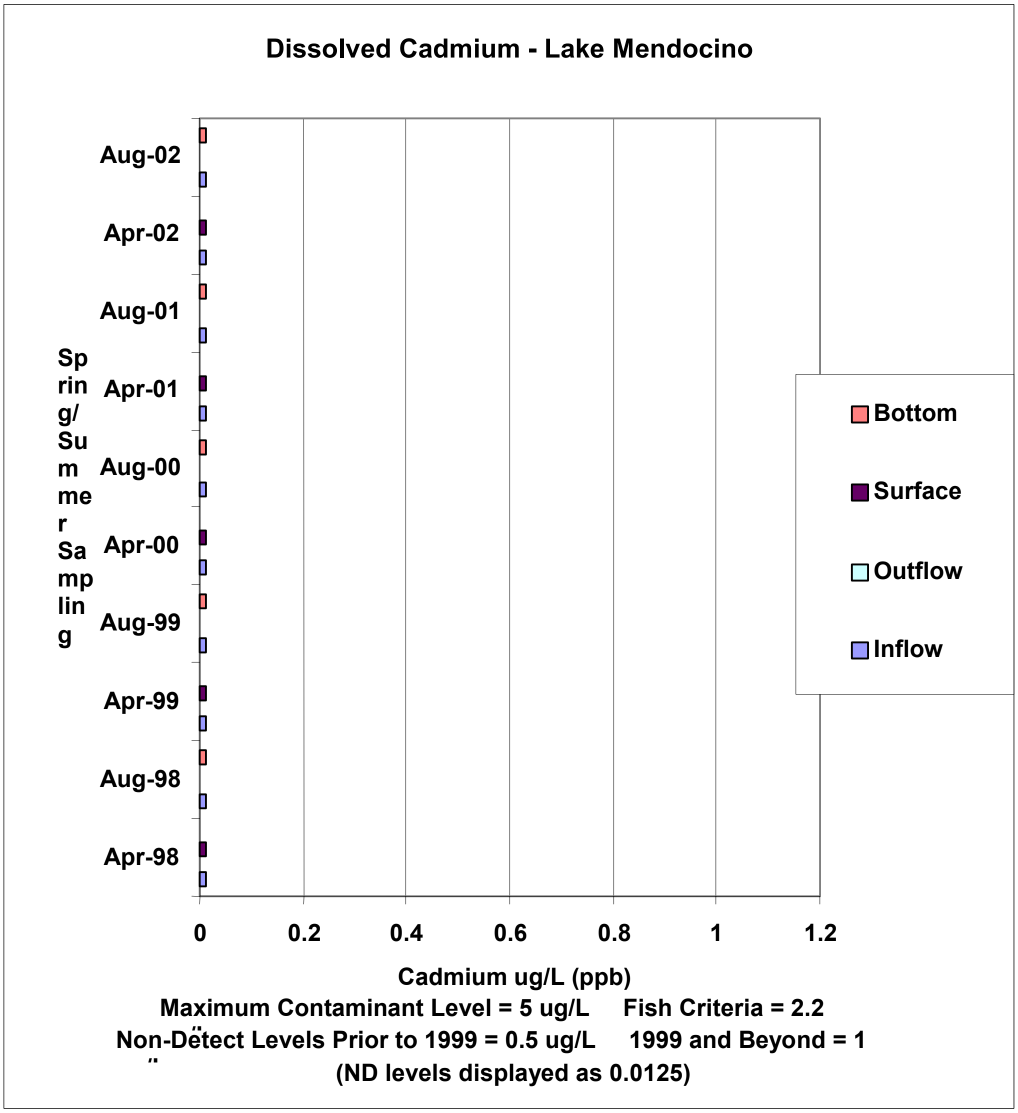
LAKE MENDOCINO					
Sample Location: Behind dam				**Date:** 8/29/02	
Observers: Tim McLaughlin				**Time:** 9:45 am	
Lake Elevation: 723.25					
Weather Conditions:					
Wind Speed: 0		**Precipitation:** 0		**Temp (F):** 65	
SECCHI Depth: 8 feet and 10 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
18.1	59.1	22.71	190	1.33	7.25
16	52.5	22.96	190	1.37	7.29
14	45.9	23.17	190	1.94	7.40
12	39.4	23.24	191	2.34	7.47
10	32.8	23.35	191	2.62	7.50
8	26.2	23.51	191	3.07	7.66
6	19.7	23.68	191	3.56	7.80
4	13.1	23.76	191	3.51	7.94
2	6.6	23.76	191	3.55	7.86
0.03	1	23.75	191	3.55	7.81
EAST FORK RUSSIAN (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
71.4	7.85		-	-	-
VISUAL OBSERVATIONS: Reservoir very low.					

Appendix C: Phytoplankton Data and Charts

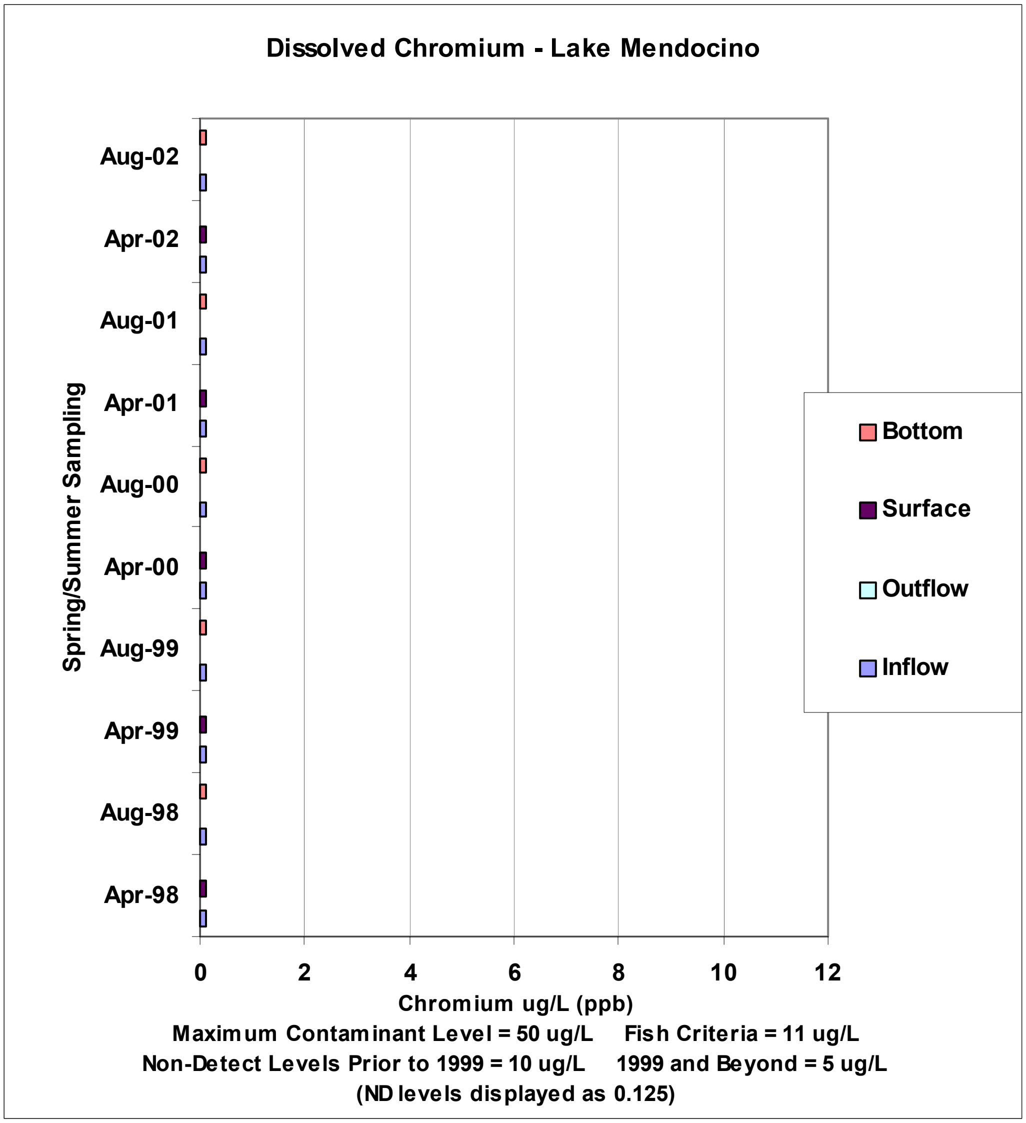

Phytoplankton Biomass 2002
Lake Mendocino / Coyote Dam
Biomass (µg/L)
2000
1600
1200
800
400
0
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
24-Apr-02
.
29-Aug-02

Appendix D: Metals Data and Charts

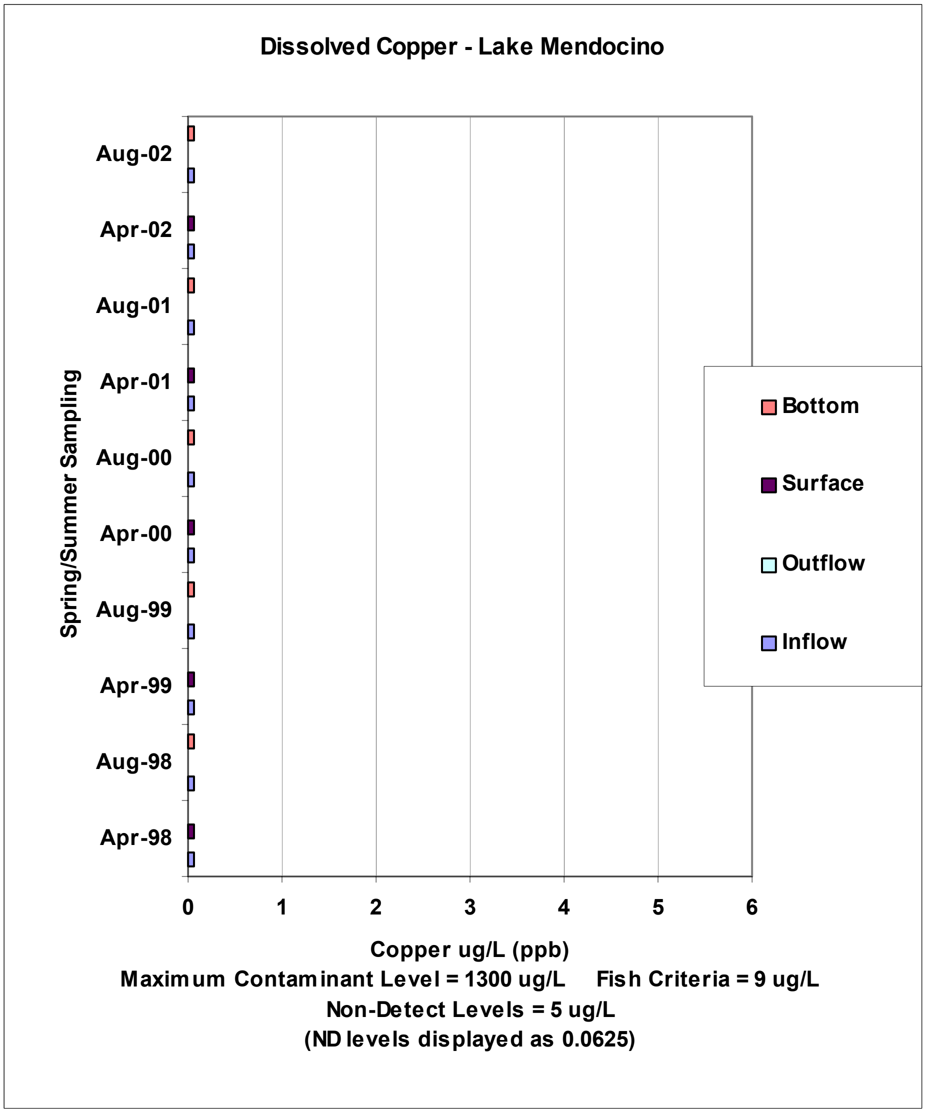

Dissolved Arsenic - Lake Mendocino
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
1
2
3
4
5
6
Bottom
Surface
Outflow
Inflow
Arsenic ug/L (ppb)
Maximum Contaminant Level = 10 ug/L Fish Criteria = 150 ug/L
Non-Detect Levels = 1 ug/L before 1999, 4 ug/L after 1999
(ND levels displayed as 0.05)



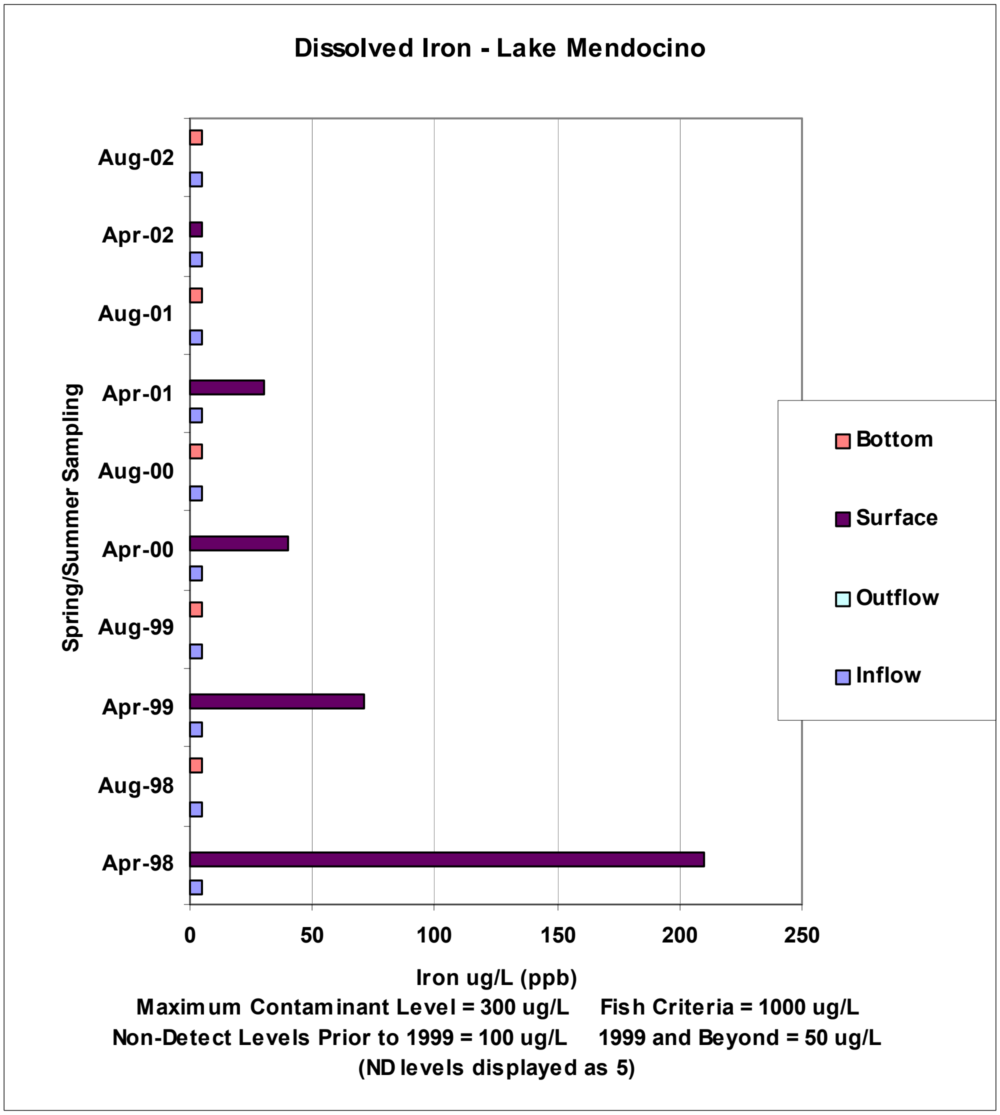
Dissolved Cadmium - Lake Mendocino
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.2
0.4
0.6
0.8
1
1.2
Bottom
Surface
Outflow
Inflow
Cadmium ug/L (ppb)
Maximum Contaminant Level = 5 ug/L Fish Criteria = 2.2
Non-Detect Levels Prior to 1999 = 0.5 ug/L 1999 and Beyond = 1
(ND levels displayed as 0.0125)



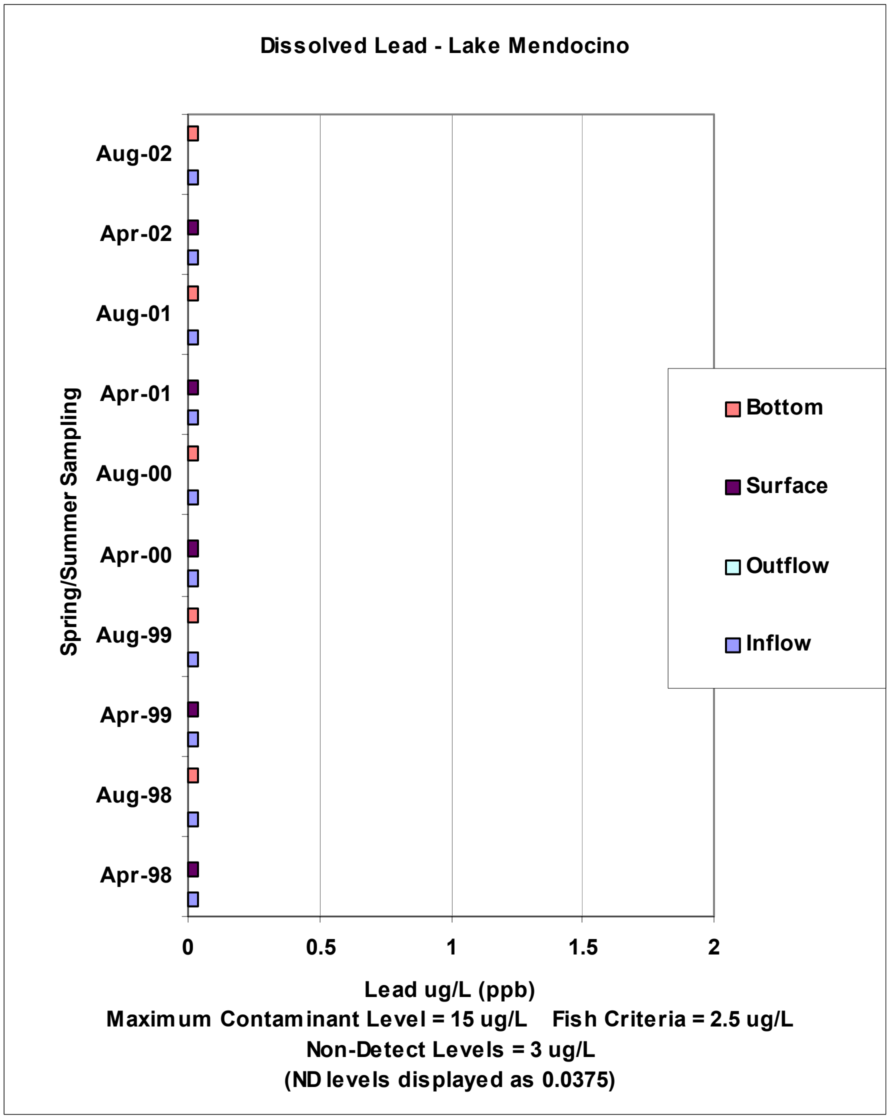
Dissolved Chromium - Lake Mendocino
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
10
12
Chromium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L
Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L
1999 and Beyond = 5 ug/L
(ND levels displayed as 0.125)
Bottom
Surface
Outflow
Inflow



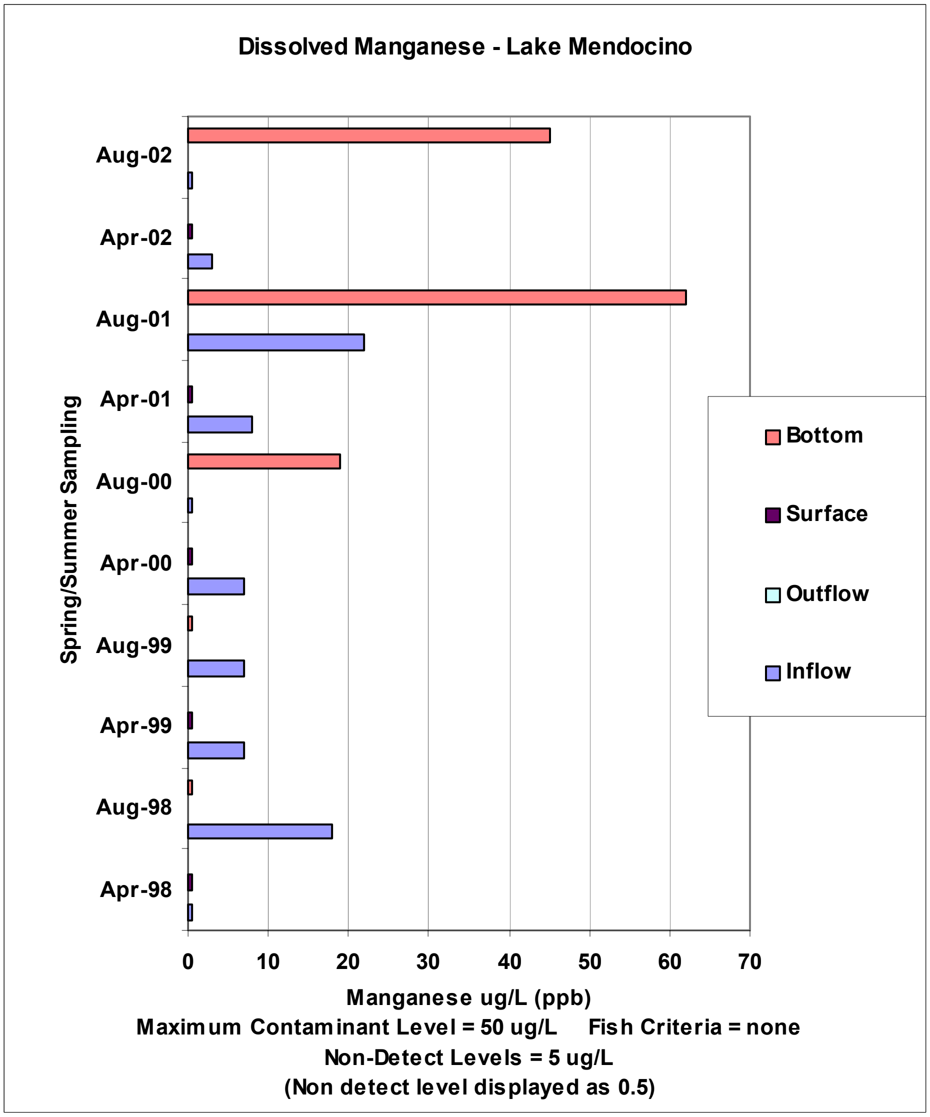
Dissolved Copper - Lake Mendocino
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
5
6
Bottom
Surface
Outflow
Inflow
Copper ug/L (ppb)
Maximum Contaminant Level = 1300 ug/L Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L
(ND levels displayed as 0.0625)

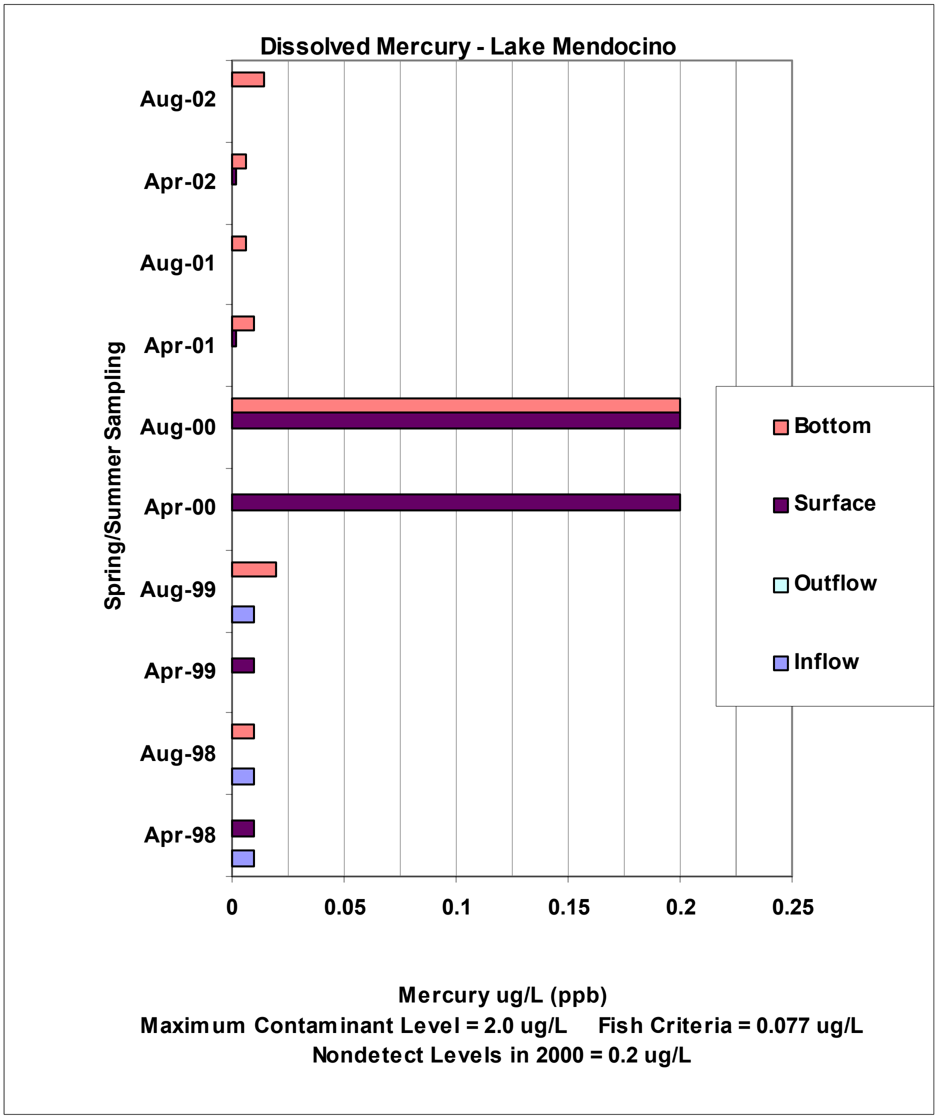


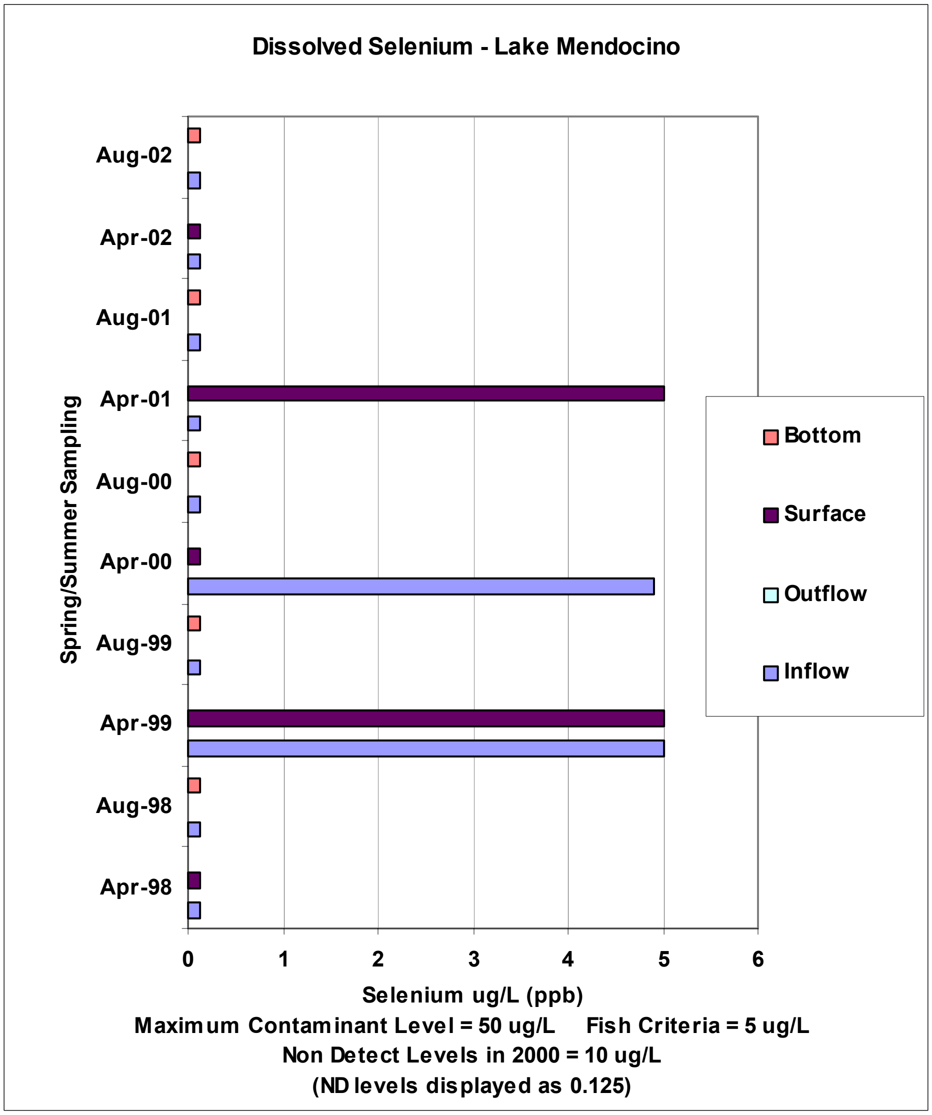
Dissolved Iron - Lake Mendocino
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
50
100
150
200
250
Iron ug/L (ppb)
Bottom
Surface
Outflow
Inflow
Maximum Contaminant Level = 300 ug/L Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L 1999 and Beyond = 50 ug/L
(ND levels displayed as 5)



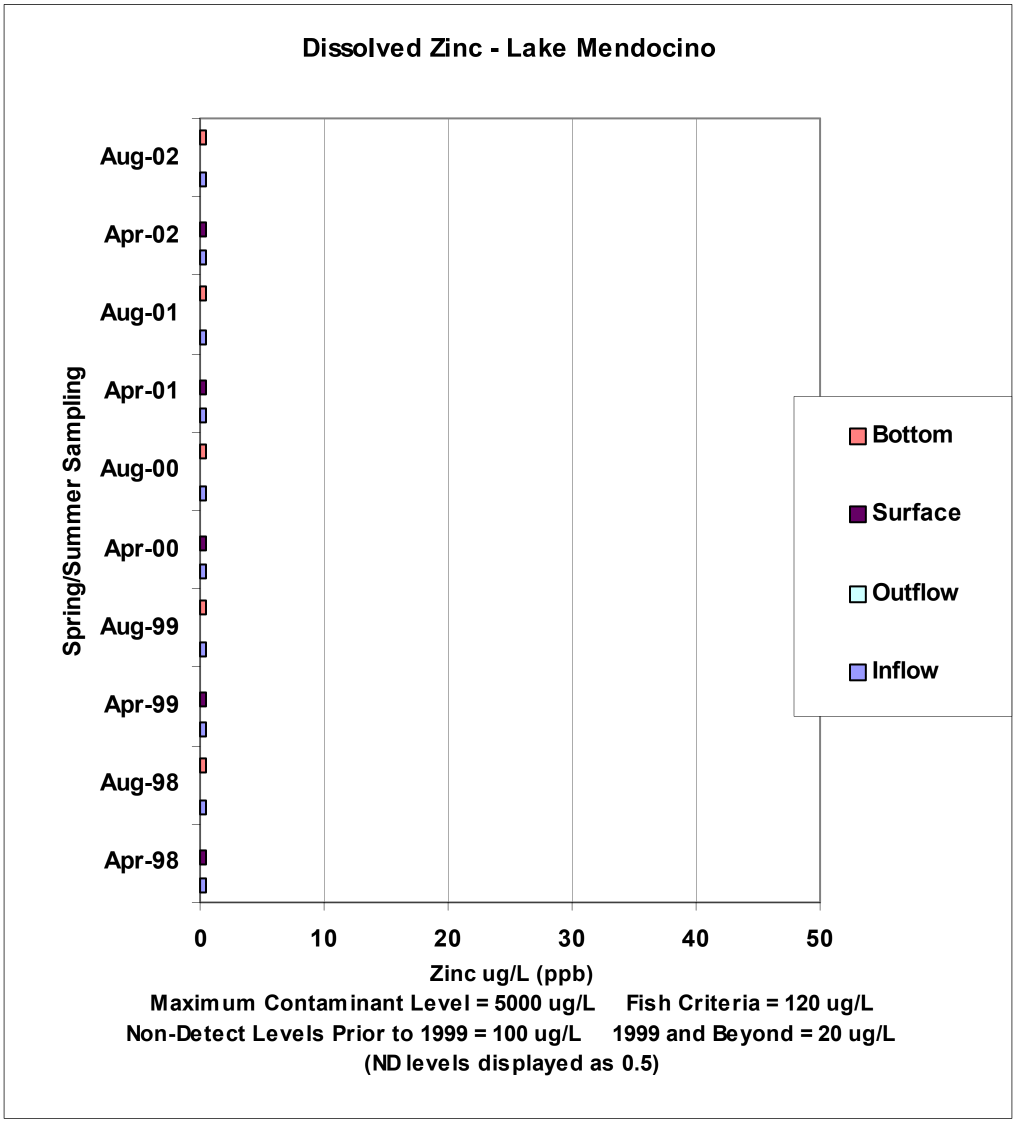
Dissolved Lead - Lake Mendocino
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
0.5
1
1.5
2
Bottom
Surface
Outflow
Inflow
Lead ug/L (ppb)
Maximum Contaminant Level = 15 ug/L Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L
(ND levels displayed as 0.0375)


Dissolved Manganese - Lake Mendocino
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
10
20
30
40
50
60
70
Bottom
Surface
Outflow
Inflow
Manganese ug/L (ppb)
Maximum Contaminant Level = 50 ug/L
Fish Criteria = none
Non-Detect Levels = 5 ug/L
(Non detect level displayed as 0.5)


Dissolved Mercury - Lake Mendocino
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.05
0.1
0.15
0.2
0.25
Bottom
Surface
Outflow
Inflow
Mercury ug/L (ppb)
Maximum Contaminant Level = 2.0 ug/L
Fish Criteria = 0.077 ug/L
Nondetect Levels in 2000 = 0.2 ug/L



Dissolved Selenium - Lake Mendocino
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
1
2
3
4
5
6
Bottom
Surface
Outflow
Inflow
Selenium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L   Fish Criteria = 5 ug/L
Non Detect Levels in 2000 = 10 ug/L
(ND levels displayed as 0.125)


Dissolved Zinc - Lake Mendocino
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
10
20
30
40
50
Zinc ug/L (ppb)
Bottom
Surface
Outflow
Inflow
Maximum Contaminant Level = 5000 ug/L   Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L   1999 and Beyond = 20 ug/L
(ND levels displayed as 0.5)

Appendix E: Inorganic Sample Data

Inorganic Results (mg/L) For surface lake waters (spring)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity		60	40	50	60	30	40	70	80	20		100
Ammonia		<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Chloride		21	2	21	4	4	3	<1	6	5		4
Nitrate		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1		<0.1
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Sulfate		5.3	2.6	4.2	8.9	2	1	8.2	9	2.1		4.7
Kjeldahl N		0.6	0.1	0.4	0.2	<0.1	0.3	0.2	0.2	0.2		<0.1
COD					<50							
Tot Solids		120	70	100	110	60	78	100	120	21		150

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	100	70	40	50	20	30	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	13	25	3	21	<1	<1	4	<1	6	4	3	2
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	
Sulfate	18	2.1	2.3	3	2.8	1.9	0.8	8.8	11	1.6	11	3.5
Kjeldahl N	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1
COD	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	170	130	59	110	60	60	90	110	150	30	130	90

Inorganic Results (mg/L) For surface lake waters (summer)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	140	70	40	50	50	40	70	90	80	10	80	110
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
Chloride	16	26	4	19	6	5	5	5	9	3	5	8
Nitrate	<0.1	1.5	<0.1	1.3	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1
Total P	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	16	4.1	3.6	3.5	5.9	2	0.7	7.4	14	1.6	6.4	4.4
Kjeldahl N	<0.1	2.7	<0.1	0.4	0.4	0.3	<0.1	0.2	<0.1	<0.1	0.2	0.6
COD	<50	60	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	200	190	50	120	98	80	80	120	120	52	100	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	90	40		60	40	80	100	130	20	110	180
Ammonia												
Chloride	16	490	5		10	8	3	5	14	4	5	22
Nitrate												
Total P												
Ortho P												
Sulfate	16	4.5	3		9.8	3.2	<0.5	6	14	2.7	5.4	8.7
Kjeldahl N												
COD												
Tot Solids	200	1300	50		140	100	100	150	200	50	140	280

Appendix F: MTBE Table

2002 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2002 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	2		2		<2		<2		
Eastman	5				<2				
Englebright	3		3		10		10	10	
Hensley	3		3		3		3		
Isabella	<2	<2	<2	<2	<2	<2	<2	<2	
Kaweah	2		2	<2	8		6	6	
Martis Cr.	<2				<2				
Mendocino	<2				<2				
New Hogan	<2				3				
Pine Flat	<2		<2		2		2		
Sonoma		3	<2		<2		2		
Success	4		4	4	11	12	11	11	

Notes:

1. Non-Detect is indicated by "<2" since the Reporting Limit is 2 ppb or 0.002 ppm.

2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.

3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.

4. For 2002, the number of MTBE water sampling at each lake is based on last year's lab results.

5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was historically non-detectable. The 2002 results of non-detectable levels were similar except Lake Eastman and New Hogan now reported low, detectable levels of MTBE.

6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because of historically low detectable levels of MTBE.

7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because of historically higher MTBE being found. The 2002 results were similar except Isabella now reported non-detectible levels.

8. In 2001, very high MTBE levels were reported at Lake Isabella during the Spring (18 ug/L near the marina) . During Spring 2000, Lake Isabella reported 21 ug/L. The 2002 results indicate that the previous MTBE problem near the marina was not visible during the Spring 2002 sampling event, and may have been rectified.

G. Fish tissue analysis table

2002 Fish Tissue Results

The following table provides an overview of the lab results for the 2002 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conductng the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The California OEHHA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Mercury Total ppm	FDA Criteria
Black Butte	Sm M Bass	Composite (3)	6/12/02	0.24	0.26	1 ppm
Eastman	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Englebright	Note 5	N/A	N/A	N/A	N/A	
Hensley	Black Bass	Composite (3)	4/23/02	<0.10	0.72	1 ppm
Isabella	Black Bass	Composite (3)	6/4/02	0.20	0.21	1 ppm
Kaweah	Sm M Bass	Composite (3)	7/14/02	0.11	0.53	1 ppm
Martis Cr	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Mendocino	Note 6	N/A	N/A	N/A	N/A	
New Hogan	Lg M Bass	Single (1)	6/3/02	<0.10	0.34	1 ppm
Pine Flat	Note 4	--------------------	-----------	----------	-----------	< Mon 01
Sonoma	Note 6	N/A	N/A	N/A	N/A	
Success	Black Bass	Composite (3)	4/15/02	<0.10	0.18	1 ppm

Notes:

9. Non-Detect is indicated by "<0.02". The lab Detection Limit for mercury is 0.02 ppm.
10. Total Mercury was reported in mg/g or ppm.
11. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.
12. The fish tissue program was terminated at Eastman and Martis Creek in 2001 and in Pine Flat in 2002 due to low total mercury results. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout). For Pine Flat total mercury was 0.21 ppm in 2000 (composite of three Sacramento Sucker fish) and 0.23 in 2001 (composite of three spotted bass).
13. Due to seasonal conditions, a fish could not be successfully collected at Lake Englebright. Another attempt will be accomplished for the 2003 report.

14. Fish were not collected at Mendocino or Sonoma due to communication difficulties.

The above 2002 total mercury results indicate only Hensley is higher than average. However, in 2001, the total mercury results were only 0.30 ppm for Hensley (small mouth bass). The 2003 fish tissue program should provide additional data. EPA fact sheet on fish advisories (EPA-823-F-99-016) indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.

Annual Water Quality Report

NEW HOGAN LAKE

Water Year 2002

Written by
John J. Baum
Water Quality Engineer
U. S. Army Corps of Engineers
Sacramento District
January 2003

TABLE OF CONTENTS

New Hogan Lake

I. Purpose

This report is part of an environmental monitoring program that started at New Hogan Lake in August 1974. The monitoring program was implemented to ensure a continuous level of water quality in the lake for both recreation and environmental health and to satisfy the Department of Army Engineering Regulation 1110-2-8154, "Water Quality and Environmental Management for Corps Civil Works Projects".

II. Brief Description of New Hogan Lake

New Hogan Lake is located in central California, 30 miles east of Stockton, California. Surrounding the lake are the oak and brush covered foothills of the Sierra Nevada Mountains. At capacity the lake has 4,400 surface acres, 50 miles of shoreline, and is nearly 8 miles long. The lake was created by the completion of New Hogan Dam on the Calaveras River in 1964. The structure provides flood damage reduction, water conservation, and hydroelectric power. Since being built for flood control and irrigation, the lake has also become a popular destination for recreation.

Water quality monitoring by the United States Army Corps of Engineers (USACE) began at New Hogan Lake in August 1974. Generally there are two sample events a year, spring (April) and late summer (August). Since the start of the monitoring program, a water quality report is produced yearly to list results and address any concerns of the previous water year.

Generally, New Hogan Lake has a depth of less than 150 feet during the sampling events, and is considered a mesotrophic lake when characterized by its clarity. A mesotrophic lake is one that has physical qualities in between an oligotrophic (clear and nutrient limited; example Lake Tahoe) and an eutrophic lake (low clarity and high in nutrients and biomass; example Clear Lake). New Hogan Lake cannot maintain a dissolved oxygen concentration greater than 5 mg/L in its bottom waters during warm late summer months. Most of New Hogan Lake remains relatively cool (<20ºC) in the late summer. Due to the low dissolved oxygen concentrations in the lake during the late summer, coldwater fish species may have difficulties breeding and surviving in the lake year round. Although clearer than eutrophic (nutrient rich) lakes, mesotrophic lakes can have low water clarity due to algal blooms and suspended sediments in shallow areas. Water clarity is often measured in terms of Secchi Disc depth or SD (Appendix A). Historically, the water clarity in New Hogan Lake is very good with none of the fifty-five sampling event SD values below the recreational goal of 4 feet (Figure 1). In 2001 the Spring SD measure was 17.67 feet and the late summer sample event had a SD of 13.33 feet.

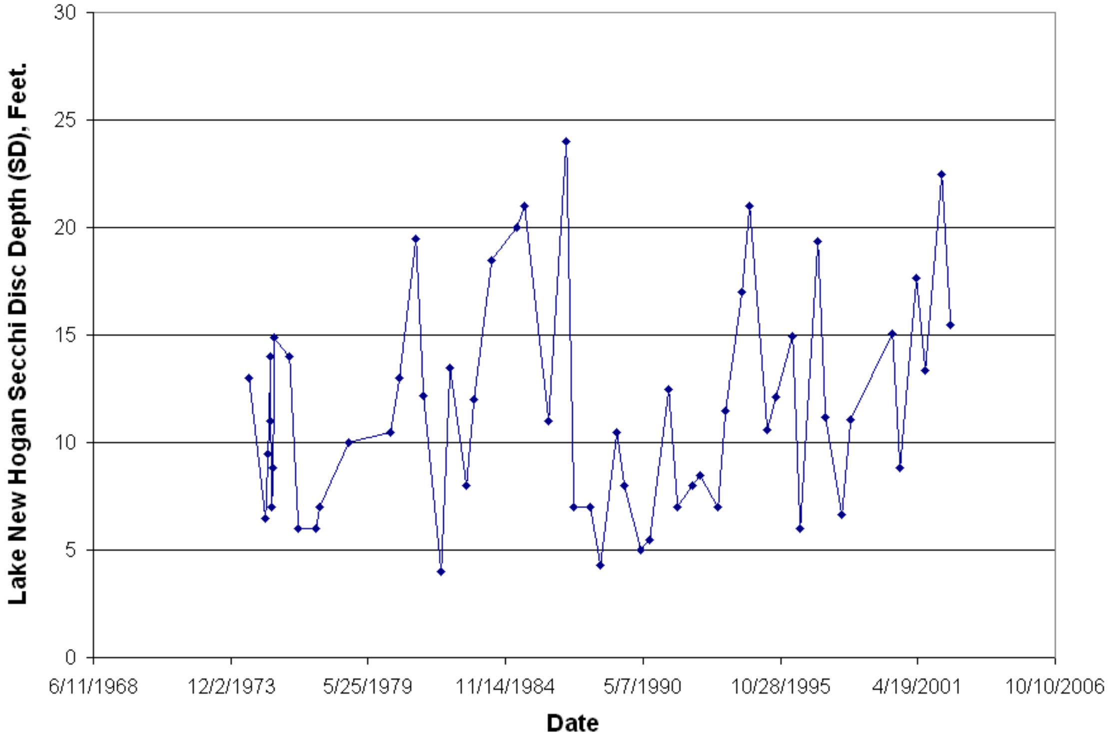


Figure 1. Historical Secchi Depth Values at New Hogan Lake (2002 values included).

The 2001 Water Quality Report listed only mercury in fish tissue as a contaminant of concern at New Hogan Lake. In 2000, the composite fish tissue sample resulted in a concentration of 0.52 ppm, which was below the U.S. FDA fish advisory of 1 ppm, but above the California Office of Environmental Health Hazard Assessment (OEHHA) action level concentration (0.3 ppm Hg) to continue monitoring. In 2001, the concentration of mercury within fish tissue continued to remain high (0.6 ppm).

III. Sample Summaries for this year.

Introduction

The following general summaries are split into their respective sample types. Each type of sample summary includes a discussion of both the spring (April) and late summer (August) samples to better examine trends within the current year. The types of parameters monitored this year include: Secchi Disc depths, water column profiles (temperature, DO and pH), phytoplankton characterization, metals concentrations, MTBE concentrations, Inorganic characterization (alkalinity, phosphorous, nitrogen, etc..), and Fish mercury sampling. For a more detailed explanation of the importance of each type of sample, please see Appendix A.

SECCHI DEPTH

The Secchi Disc depths found during the spring and late summer sampling events were higher than the historical average(historical mean SD = 11.6 feet). More often the clarity is better in the spring than in the late summer, but not always. At the spring sampling event the water clarity was high (Spring 2002 SD = 22.5 feet), which was higher than the previous year (2001 Spring SD = 17.67 feet). The late summer SD of 15.5 feet was above the recreational goal of 4 feet but less than the previous year (Summer 2001 SD = 13.33 feet) (Appendix B).

TEMPERATURE VALUES

The temperature profiles for New Hogan Lake are indicative of a well stratified lake. There is a small depth difference between the spring and late summer sampling events (spring depth = 124.7 feet, late summer depth= 137.6 feet). Due to being stratified, the average temperatures were not very different (spring average temp. = 10.91 ºC, late summer average temp.= 15.87 ºC). New Hogan Lake is able to regulate its temperature due to having a cooler deep-water area throughout the year to buffer it from the warm summer air temperatures. Temperatures in New Hogan Lake should be able to support an ongoing coldwater fish species population. For detailed results obtained during the sampling events, please see Appendix B.

DISSOLVED OXYGEN

The dissolved oxygen (DO) concentration differs greatly from spring to late summer. In the spring DO concentrations are 10.73 mg/L near the surface and 6.6 mg/L at the bottom of the lake. DO concentrations near the surface are above saturation, which is 9.78mg/L at 16.4 º C. The elevated concentration of DO near the surface in the spring was due to photosynthesis occurring in lake phytoplankton. Dissolved oxygen concentrations during the late summer were highest near the surface (DO = 6.44 mg/l) and lowest near the bottom of the lake (DO = 3.25 mg/l). Fish species that require greater than 5 mg/l DO at cooler water temperatures (< 20ºC) may have difficulty thriving year round in New Hogan Lake. For detailed results obtained during the sampling events, please see Appendix B.

PH LEVELS

In the spring and late summer sampling events, pH values in the lake were slightly basic throughout the water column. In the spring sampling event the highest pH was near the surface (Spring 2002 surface pH ~ 7.25) and the lowest was at the bottom (Spring 2002 bottom pH = 7.12) The pH values in the late summer profile varied widely and were slightly more basic. The pH was most basic towards the middle waters (Late Summer 2002 max pH = 8.88) and slightly less basic bottom (Late Summer 2002 pH bottom = 7.43). For detailed results obtained during the sampling events, please see Appendix B.

PHYTOPLANKTON

In the spring sample, the algal biomass within the lake was lower (Biomass = 42.97 ug/L) than spring 2001 (2001 Spring biomass = 263.97 ug/L). In spring 2001 diatoms were the most dominant species, while cryptomonads were most dominant in 2002. In late summer an opposite trend occurred. The phytoplankton population was higher in summer 2002 (2002 Summer Biomass = 750.92 ug/L) than summer 2001 (2001 Summer Biomass = 206.60 ug/L). Diatoms were the most dominant species during both the 2001 and 2002 late summer sampling events. For detailed results obtained during the 2002 sampling events, please see Appendix C.

METALS

None of the dissolved metal samples exceeded the maximum contaminant level (MCL) or the freshwater fishery criteria during the 2002 spring and summer sampling events.

Contaminants will continue to be monitored in the coming year for any changes. For detailed results obtained during the sampling events, please see Appendix D.

MTBE

Concentrations for MTBE at the lake were found to be below the detection limit (< 2 ppb) in the spring and 3 ppb at late summer sampling events. MTBE is not seen as a contaminant of concern in New Hogan Lake at this time. For detailed results obtained during the sampling events, please see Appendix F.

INORGANIC ANALYSIS

The spring and summer sample results were within expected ranges and levels. For detailed results obtained during the 2002 sampling events, please see Appendix E.

FISH TISSUE ANALYSIS

Since only one fish was caught in New Hogan Lake, no composite sample was analyzed. Tissue from a single large mouth bass caught on June 3, 2002 was analyzed for mercury content. The tissue was found to have a mercury concentration of 0.34 ppm, which is above the EPA's action level to continue monitoring. The 2002 single fish concentration was lower than the two previous years composite samples (2001 fish composite mercury = 0.60 ppm, 2000 fish composite mercury = 0.52 ppm).

IV. Conclusions

New Hogan Lake is a mesotrophic lake that can support warmwater fish species. Coldwater fish that require dissolved oxygen concentrations greater than 5 mg/L may have difficulties surviving the late summer conditions at New Hogan Lake.

In the 2002, New Hogan Lake sampling results indicated that there were no high values resulting in contaminants of concern. The mercury concentration of the single fish caught in the lake (in 2002) was lower than previous years, but still above the EPA's action level to continue monitoring. An area that requires improvement is fish sampling so that additional fish will be available for a composite tissue result.

V. References

North American Lake Management Society (1990). *Lake and Reservoir Restoration Guidance Manual*, EPA 440/4-90-006, U.S. Environmental Protection Agency, Washington, DC.

Novotny, V., and H. Olem (1994). *Water Quality: Prevention, Identification, and Management of Diffuse Pollution*, Van Nostrand Reinhold, New York, New York.

Tchobanoglous, G., F. L. Burton, and H. D. Stensel (2003) *Wastewater engineering: treatment and reuse / Metcalf & Eddy, Inc*., McGraw-Hill, Boston, MA.

Welch, E.B. (1992) *Ecological Effects of Wastewater: Applied limnology and pollutant effects,* Chapman and Hall, Cambridge University Press, Great Britain.

Wetzel, R.G. (1975). *Limnology*, W.B. Saunders Company, Philadelphia, PA.

VI. Appendices

Appendix A: Glossary of Sample Types

Glossary of Sample Types

This glossary of sample types is intended to provide a general background and indicate the importance of each sample in determining water quality. These are meant to be brief and basic. If a further explanation is desired please refer to the list of references provided in this report.

Secchi Depth

One of the oldest and easiest methods to determine lake clarity is the Secchi depth (SD). The Secchi depth is determined by dropping a Secchi disc into a water body and determining the depth that it is last visible from the surface of the water. Secchi discs are generally white and 20 cm in diameter. Secchi depth values are most impacted by the light intensity at the time of sampling and the scattering of light by solid particulates within the water column. Algal growth (phytoplankton) and sediment re-suspension are often major constituents of solid particulates within the water column. Secchi depth values can be used to estimate the Trophic state or the nutrient levels within the lake. The more nutrients are available, the larger likelihood of algal blooms that limit water clarity. Due to recreational concerns for safety, the goal for Secchi depth values is four feet or greater.

Temperature Profiles and Data Points

The temperature profile of a lake provides information how a lake is operating and the potential for aquatic biota to live within the lake. The temperature profile is a direct indicator if a lake is stratified. Stratification in lakes is created generally by temperature affecting the density of water molecules. Stratification is usually indicated by a region of similar temperature nearer the surface of the water (epilimnion), then a region of temperature transition (metalimnion), to another layer of nearly constant temperature at the bottom of the lake (hypolimnion). Each layer in a stratified lake is important, but the existence of a hypolimnion can drastically impact how well a lake can handle warmer temperatures such as those found in northern California during the summer. The hypolimnion acts as a buffer against large temperature shifts. The nature of dam operation is that water is discharged near the bottom, releasing the hypolimnion, and eliminating stratification. This operation limits the ability of reservoirs to regulate their temperature during the summer months. Stratification isn’t always desirable. When a lake isn’t stratified and is instead well mixed, the required nutrients near the bottom of the lake become available to phytoplankton for growth. Temperatures within lakes also indicate which species of fish will survive within a lake. Coldwater species of fish require temperatures below 20 degrees C in order to spawn and survive. If a lake is often above 20 degrees C, then only warmwater fish species will survive.

Dissolved Oxygen (DO) Concentration Profiles

DO is required by organisms for respiration and for chemical reactions within lake waters. The recommended level for DO for most aquatic species survival is 5mg/L. In lakes, biota waste (detritus) falls to the bottom of the lake to be utilized by bacteria. The bacteria need oxygen and will deplete levels near the bottom of a lake, especially during

warm temperature, high respiration conditions. For nutrient rich (eutrophic) lakes more organisms will grow, create wastes, and cause oxygen depleted regions at the lowest areas. Under these conditions only aquatic species that can survive low DO conditions in warm water near the surface will survive.

PH Profiles

The pH profiles of the lakes indicate the potential for certain chemical reactions to occur. In high pH (greater than pH = 7 or basic) aquatic systems, metal pollutants tend to form into insoluble compounds that fall onto the lake floor. In low pH (less than pH = 7 or acidic) systems or areas metal ions become soluble and available for uptake into aquatic organisms. Other compounds like ammonia that are introduced into a low pH aquatic environment will transform into soluble nitrate and be utilized by organisms.

Phytoplankton Analysis

Phytoplankton analysis indicates the health, nutrients, and biodiversity within a lake. Lakes that have few nutrients available (Oligotrophic) will generally have a much lower quantity of phytoplankton (high Secchi depth) but the number of phytoplankton species seen will be large. In a lake that is nutrient rich (eutrophic) there are generally large phytoplankton blooms (low Secchi depth), but they are made up of a couple of phytoplankton species. Certain species of phytoplankton are preferred food sources for zooplankton (small invertebrates). Generally species like diatoms and green algae can be consumed by the filter-feeding zooplankton, but species like bluegreen algae are low in nutrients and are difficult to consume. Some species like the dinoflagellates can grow horn like points to discourage potential predators. In nutrient rich waters where there is plenty of phosphorous, nitrogen can be limited for biological growth. While most species can't grow due to the lack of nitrogen, bluegreen algae (cyanobacteria) have the ability to utilize nitrogen from the atmosphere when required. This gives bluegreen algae the ability to dominate in many eutrophic lakes.

Soluble Metals Analysis

The soluble metals analysis indicates the exposure of humans and aquatic organisms to toxic metals. These metals often build up as they are consumed through the food chain. Water samples provide an indicator for additional problems. Soluble forms of metal ions are more prevalent in low pH (pH <7, or acidic) environments.

MTBE Analysis

MTBE (methyl tertiary-butyl ether) is a chemical additive to gasoline to improve combustion. Due to its high solubility, MTBE travels and blends into aquatic systems rapidly. While not found to be extremely hazardous at low levels, the offensive smell and taste is detectible by humans at extremely low concentrations. The effect of MTBE on humans and aquatic systems is still under investigation.

Inorganic Analysis

Alkalinity

Alkalinity is measured in terms of mg/L of calcium carbonate. It indicates a lakes ability to buffer incoming acidic pollution and situational changes.

Ammonia

Ammonia is a gas that is toxic to fish and is more visible at a higher pH. Ammonia is created through anthropogenic inputs, bacteria cell respiration, and the decomposition of dead cells. Due to being a gas, given time ammonia will volatilize from the water. At a lower pH, much of the ammonia is converted to ammonium (a nutrient for root bound plant life) and utilizes DO in the nitrification process.

Chloride

The chloride ion is an indicator of any salinity increases within a lake. Most fresh water aquatic species are sensitive to salinity changes.

Nitrate

Nitrate is the nitrogen product created through the nitrification of ammonium. Nitrate is a soluble form of the nutrient nitrogen and is utilized by phytoplankton.

Total Phosphorous

The total phosphorous provides a measure of both utilized and soluble phosphorous within water samples. Phosphorous is a required nutrient for plant growth and development.

Ortho Phosphorous

Ortho phosphorous is the soluble form of phosphorous that is utilized by free-floating aquatic plants (phytoplankton).

Kjeldahl N

Kjeldahl nitrogen or total Kjeldahl nitrogen (TKN) is a measure of the total concentration of nitrogen in a sample. This includes ammonia, ammonium, nitrite, nitrate, nitrogen gas, and nitrogen contained within organisms.

COD

Chemical Oxygen Demand (COD) is a measure of the total oxygen required to complete the chemical and biological demands of a sample.

Fish Tissue Analysis

Fish tissue is analyzed to examine potential exposure of humans to toxicants as well as the health of the aquatic food chain. In aquatic systems toxic contaminants can build up (or bioaccumulate) within animals at the top of the food chain. Contaminants (especially organic pollutants) are retained within the fat tissue of an organism, therefore in fish samples the lipid content is often measured.

Lake Code Designation

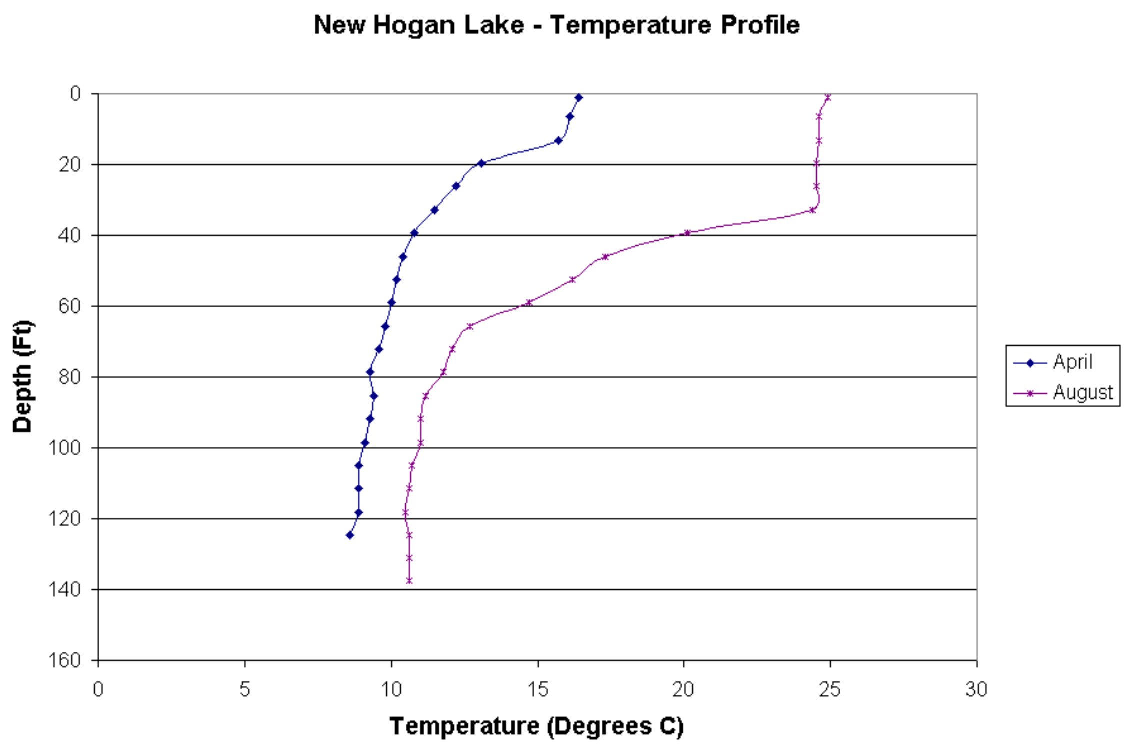
Laboratory Reports are provided in the previous sections.

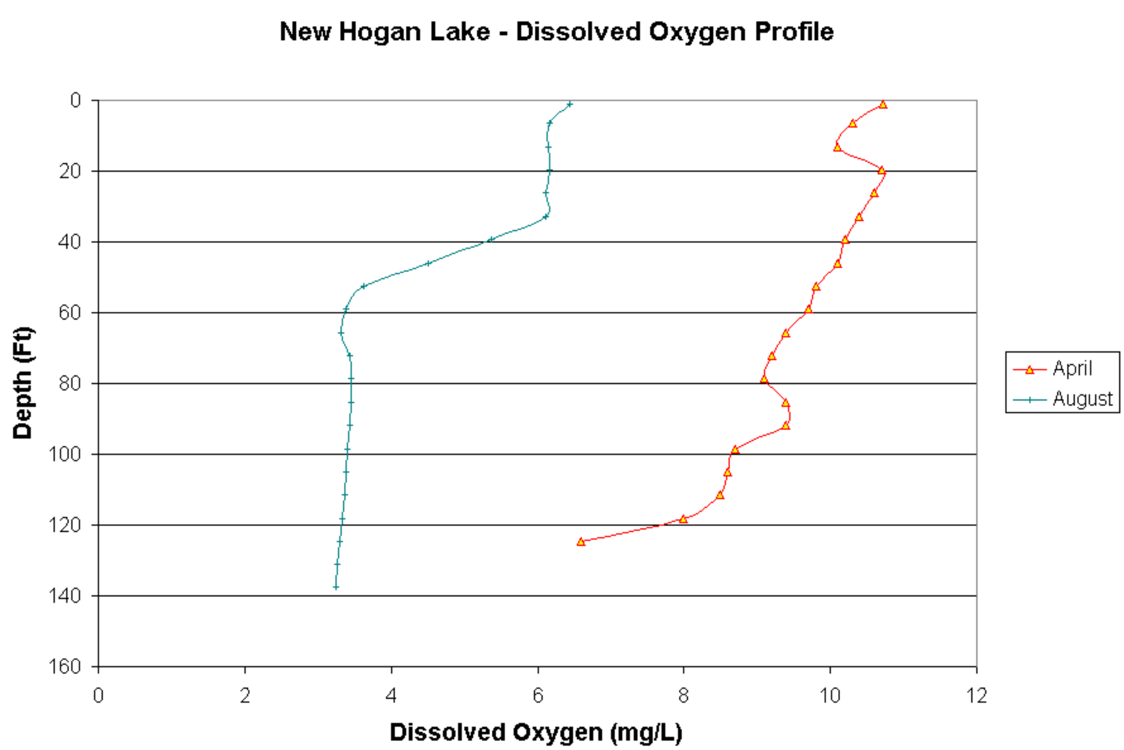
Sample ID is "XX-YY-ZZ" where

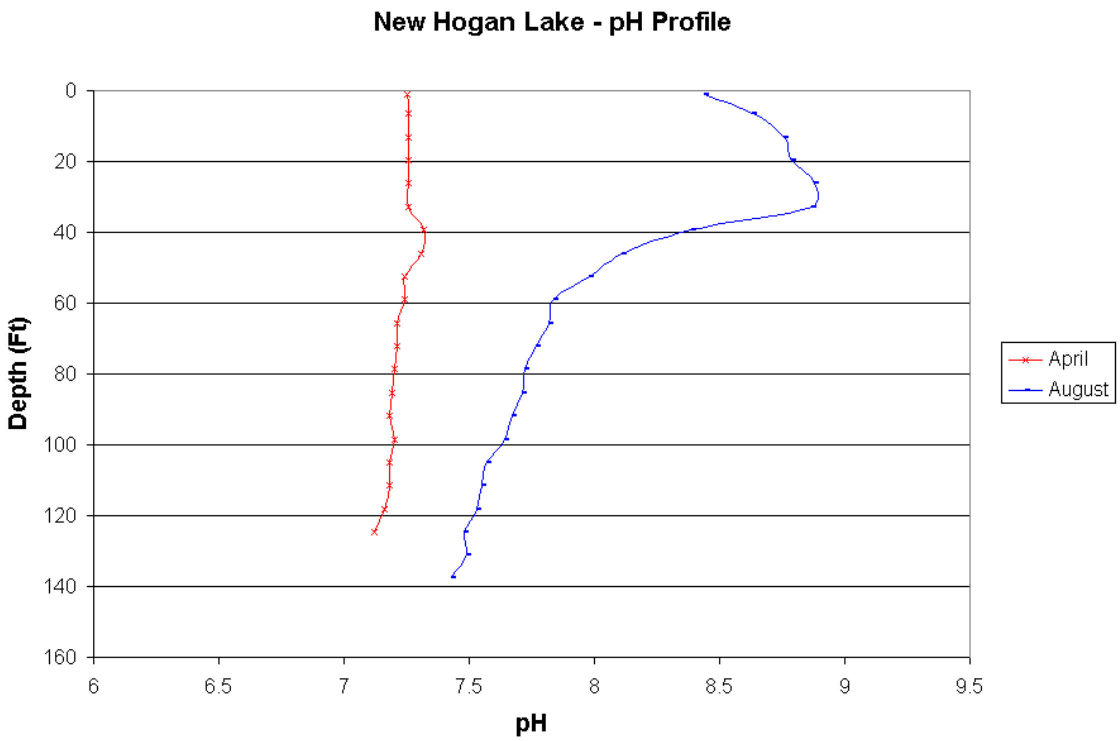
XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summar	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

Example: BB-SU-S is for a water sample taken from Black Butte in the Summer on the Lake's Surface.

Appendix B: Profile Data and Charts (Secchi Disc, Temperature, DO, and pH)


New Hogan Lake - Temperature Profile
Depth (Ft)
Temperature (Degrees C)
April
August
0
20
40
60
80
100
120
140
160
0
5
10
15
20
25
30

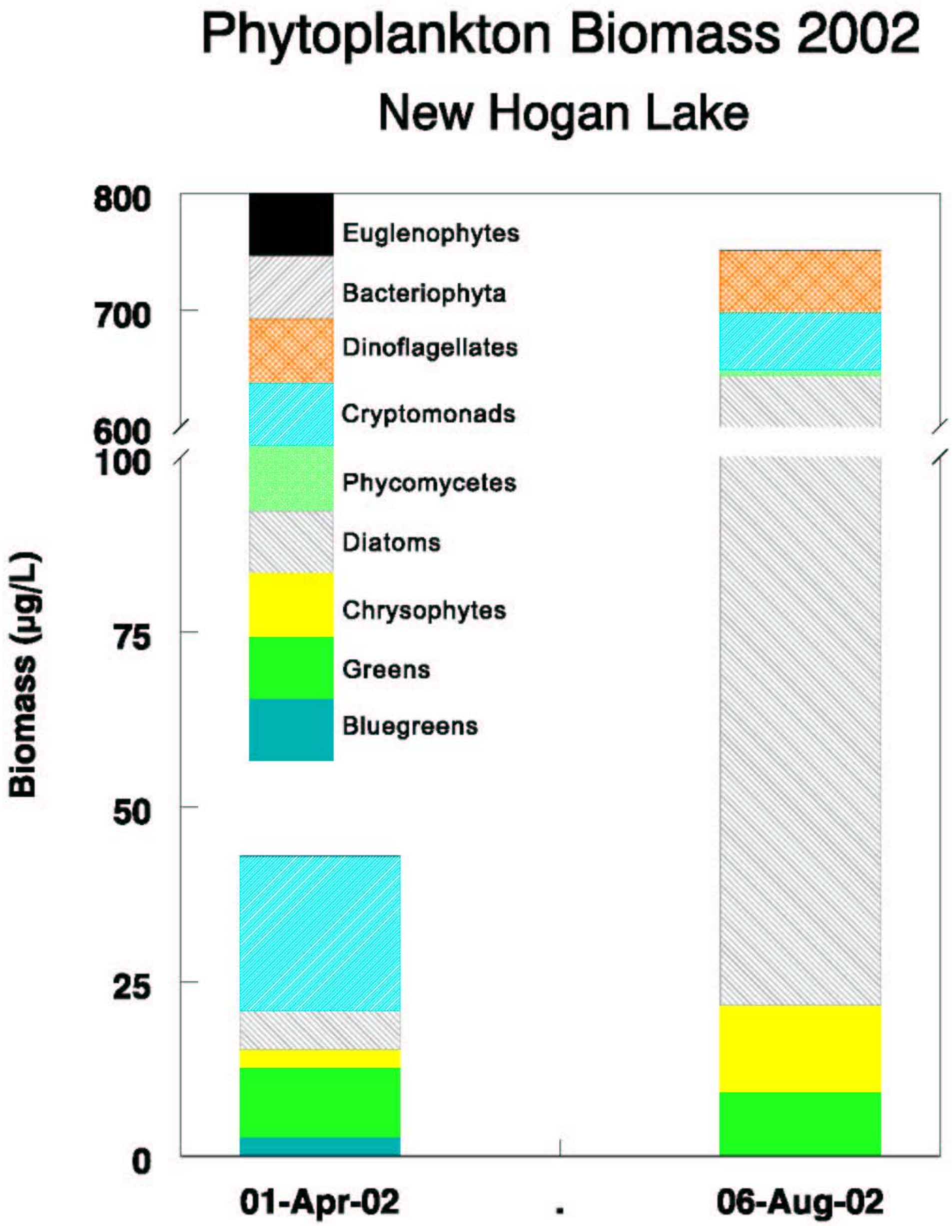

New Hogan Lake - Dissolved Oxygen Profile
Depth (Ft)
Dissolved Oxygen (mg/L)
April
August
0
20
40
60
80
100
120
140
160
0
2
4
6
8
10
12


New Hogan Lake - pH Profile
0
20
40
60
80
100
120
140
160
Depth (Ft)
6
6.5
7
7.5
8
8.5
9
9.5
pH
April
August

NEW HOGAN LAKE					
Sample Location: Behind dam				**Date:** 04/01/02	
Observers: Tim McLaughlin				**Time:** 9:40 am	
Lake Elevation: 676.1					
Weather Conditions:					
Wind Speed: 0		**Precipitation:** 0		**Temp (F):** 75	
SECCHI Depth: 22 feet and 6 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
38.1	124.7	8.60	152	6.6	7.12
36	118.1	8.90	154	8.00	7.16
34	111.5	8.90	152	8.50	7.18
32	105	8.90	153	8.60	7.18
30	98.4	9.10	154	8.70	7.20
28	91.9	9.30	153	9.40	7.18
26	885.3	9.40	154	9.40	7.19
24	78.7	9.30	154	9.10	7.20
22	72.2	9.60	153	9.20	7.21
20	65.6	9.80	153	9.40	7.21
18	59.1	10.00	153	9.70	7.24
16	52.5	10.20	154	9.80	7.24
14	45.9	10.40	154	10.10	7.31
12	39.4	10.80	154	10.20	7.32
10	32.8	11.50	152	10.40	7.26
8	26.2	12.20	153	10.60	7.26
6	19.7	13.10	154	10.70	7.26
4	13.1	15.70	154	10.10	7.26
2	6.6	16.10	154	10.30	7.26
0.03	1	16.40	154	10.73	7.25
CALAVERAS (Inflow)					
Temp (F) 64	**pH** 7.36		**DOmg/L** -	**EC** -	**Flow rate (cfs** 201
CALAVERAS (Outflow)					
Temp (F) -	**pH** -		**DOmg/L** -	**EC** -	**Flow rate (cfs** -
VISUAL OBSERVATIONS:					

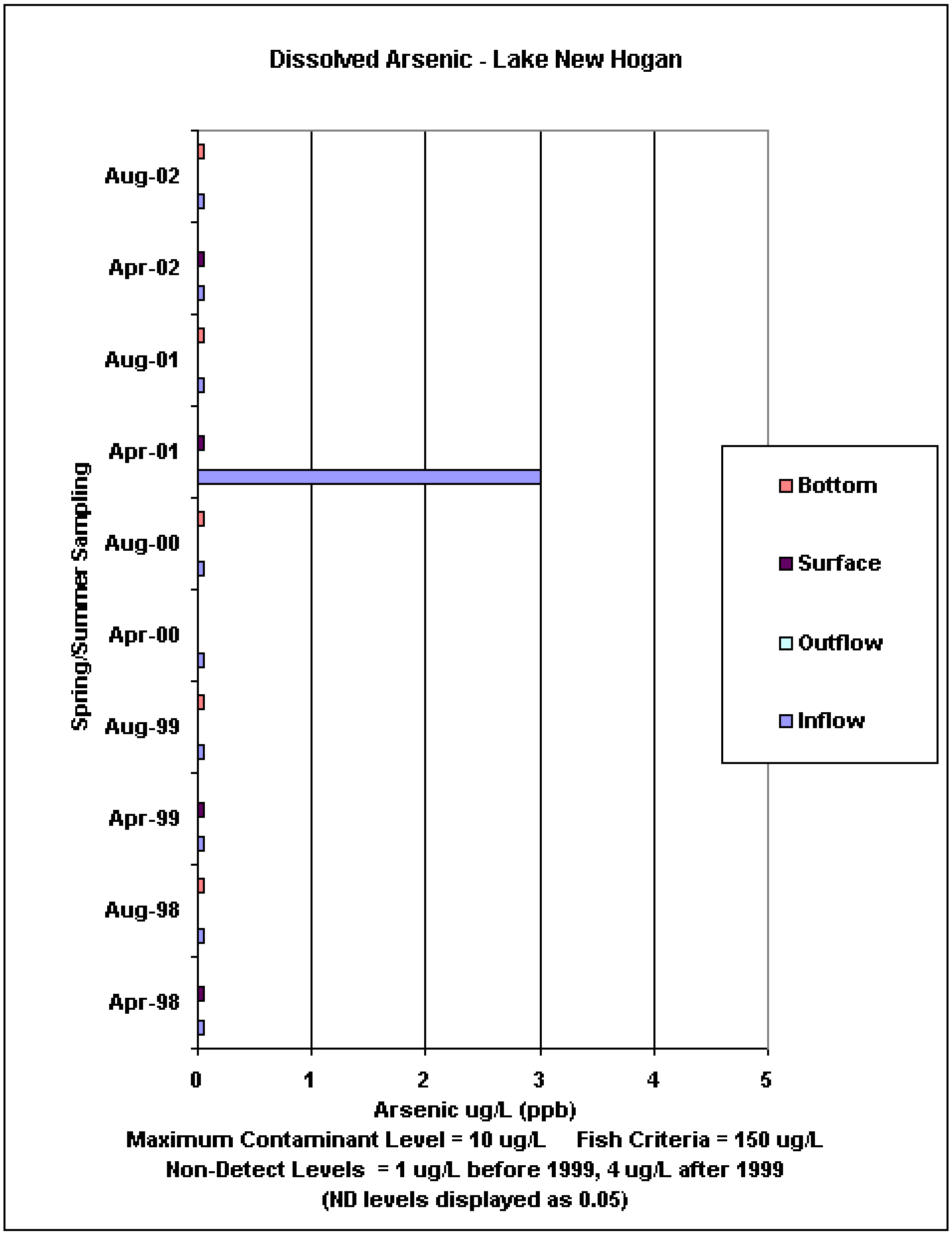
NEW HOGAN LAKE					
Sample Location: Behind dam				**Date:** 8/06/02	
Observers: Tim McLaughlin				**Time:** 10:00 am	
Lake Elevation: 664.67					
Weather Conditions:					
Wind Speed: 0		**Precipitation:** 0		**Temp (F):** 75	
SECCHI Depth: 15 feet and 6 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
40.9	137.6	10.6	187	3.25	7.43
40	131.2	10.6	187	3.27	7.49
38	124.7	10.6	187	3.30	7.48
36	118.1	10.5	187	3.34	7.53
34	111.5	10.6	187	3.37	7.55
32	105	10.7	187	3.39	7.57
30	98.4	11.00	187	3.40	7.64
28	90.9	11.00	187	3.43	7.67
26	885.3	11.20	188	3.45	7.71
24	78.7	11.80	188	3.45	7.72
22	72.2	12.10	188	3.43	7.77
20	65.6	12.70	189	3.32	7.82
18	59.1	14.70	202	3.38	7.84
16	52.5	16.20	189	3.63	7.98
14	45.9	17.30	190	4.50	8.11
12	39.4	20.10	192	5.37	8.39
10	32.8	24.40	205	6.11	8.87
8	26.2	24.50	205	6.12	8.88
6	19.7	24.50	205	6.16	8.79
4	13.1	24.60	205	6.15	8.76
2	6.6	24.60	205	6.16	8.63
0.03	1	24.90	205	6.44	8.44
CALAVERAS (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
76.2	7.67		-	-	-
CALAVERAS (Outflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
-	-		-	-	-
VISUAL OBSERVATIONS:					

Appendix C: Phytoplankton Data and Charts

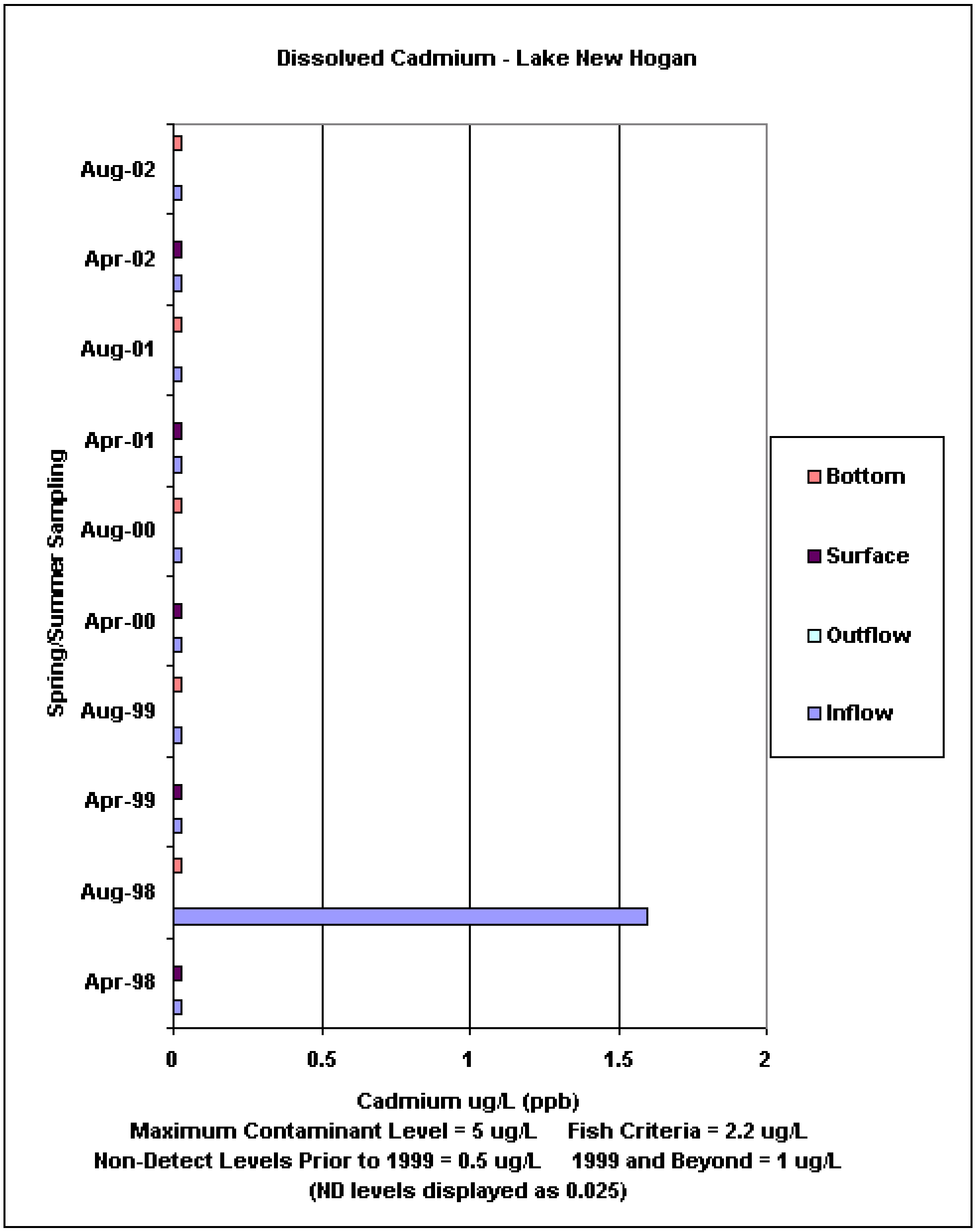


Phytoplankton Biomass 2002
New Hogan Lake
Biomass (µg/L)
800
700
600
100
75
50
25
0
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
01-Apr-02
06-Aug-02

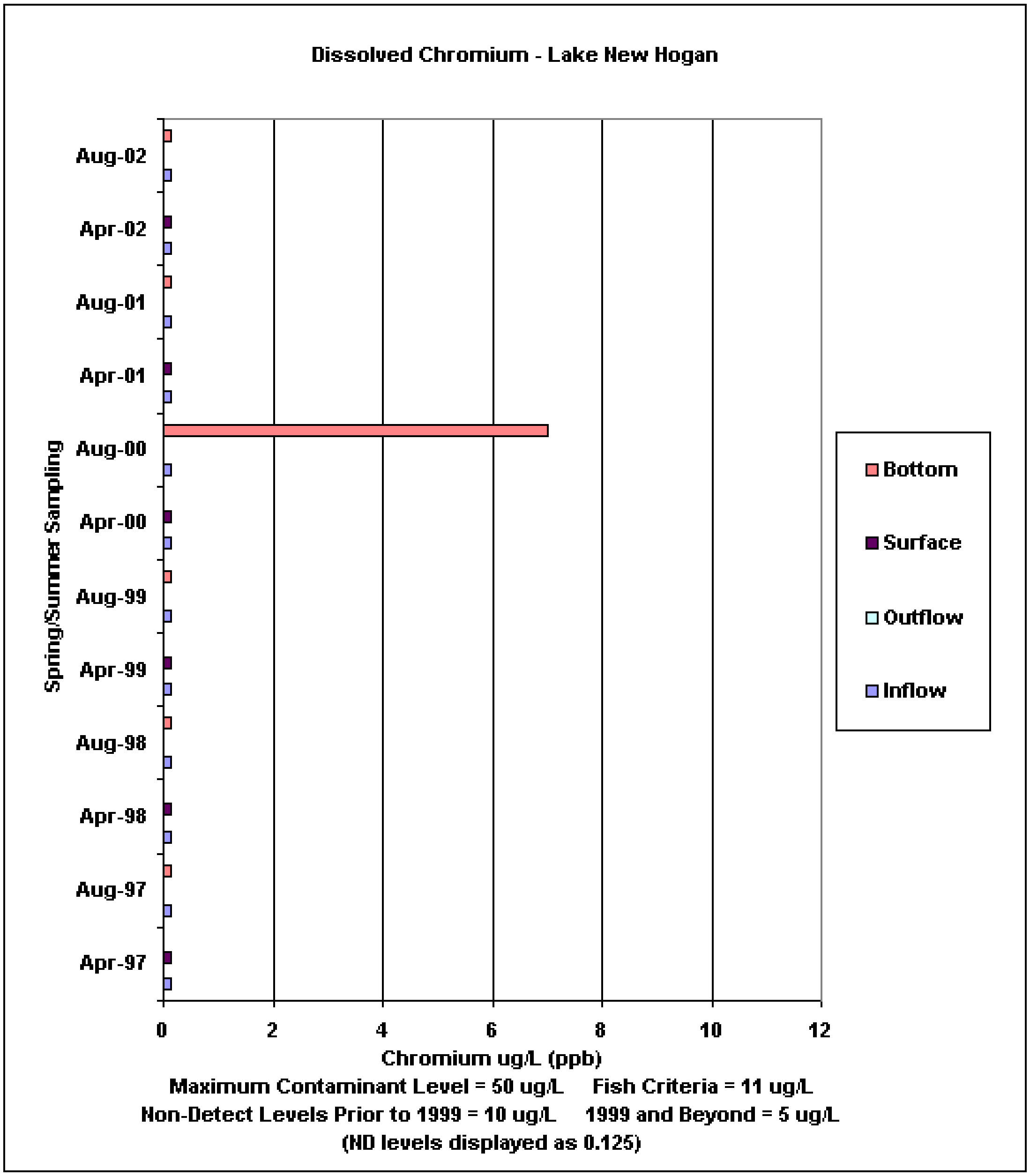
Appendix D: Metals Data and Charts



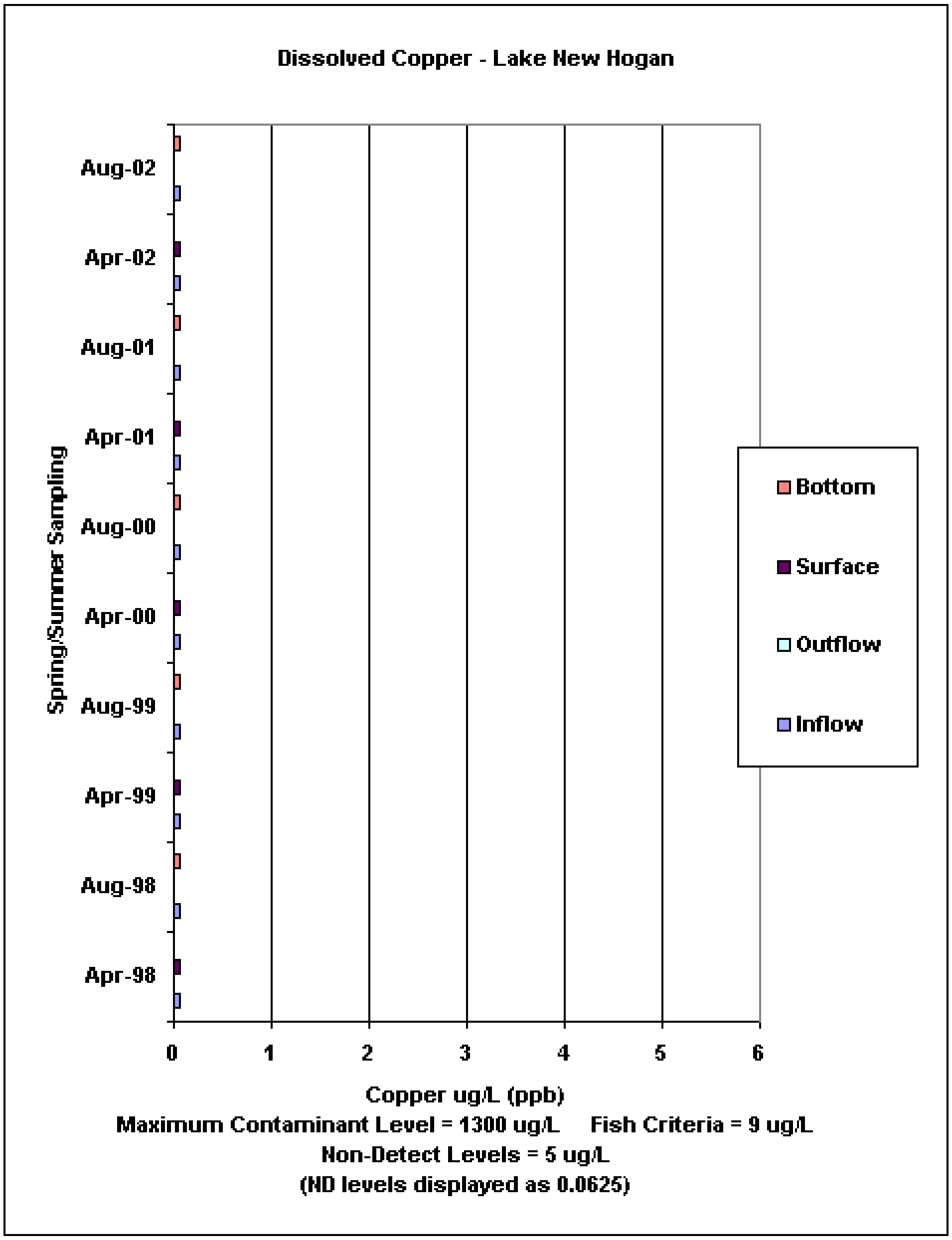
Dissolved Arsenic - Lake New Hogan
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
5
Bottom
Surface
Outflow
Inflow
Arsenic ug/L (ppb)
Maximum Contaminant Level = 10 ug/L Fish Criteria = 150 ug/L
Non-Detect Levels = 1 ug/L before 1999, 4 ug/L after 1999
(ND levels displayed as 0.05)

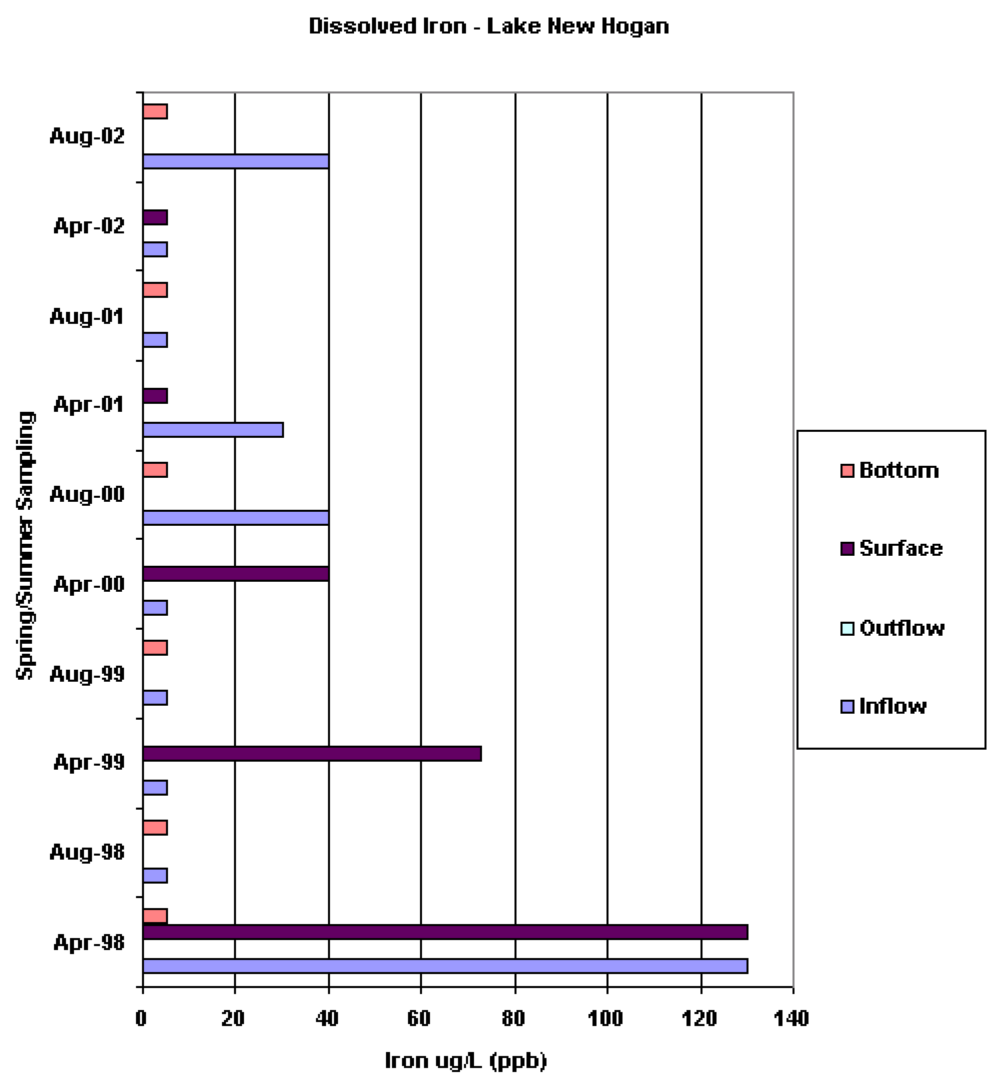


Dissolved Cadmium - Lake New Hogan
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.5
1
1.5
2
Bottom
Surface
Outflow
Inflow
Cadmium ug/L (ppb)
Maximum Contaminant Level = 5 ug/L   Fish Criteria = 2.2 ug/L
Non-Detect Levels Prior to 1999 = 0.5 ug/L   1999 and Beyond = 1 ug/L
(ND levels displayed as 0.025)

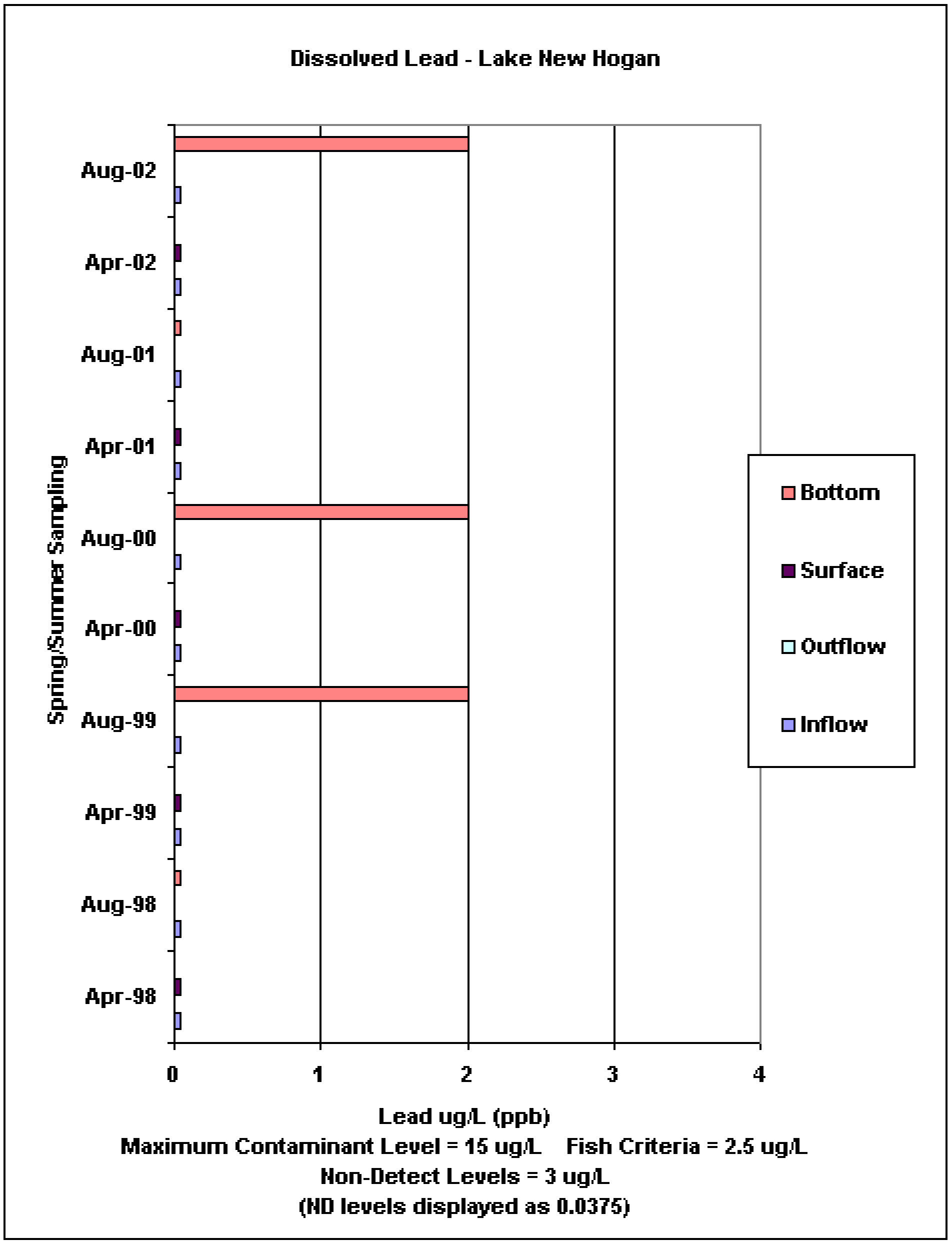


Dissolved Chromium - Lake New Hogan
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
Spring/Summer Sampling
0
2
4
6
8
10
12
Chromium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L 1999 and Beyond = 5 ug/L
(ND levels displayed as 0.125)
Bottom
Surface
Outflow
Inflow

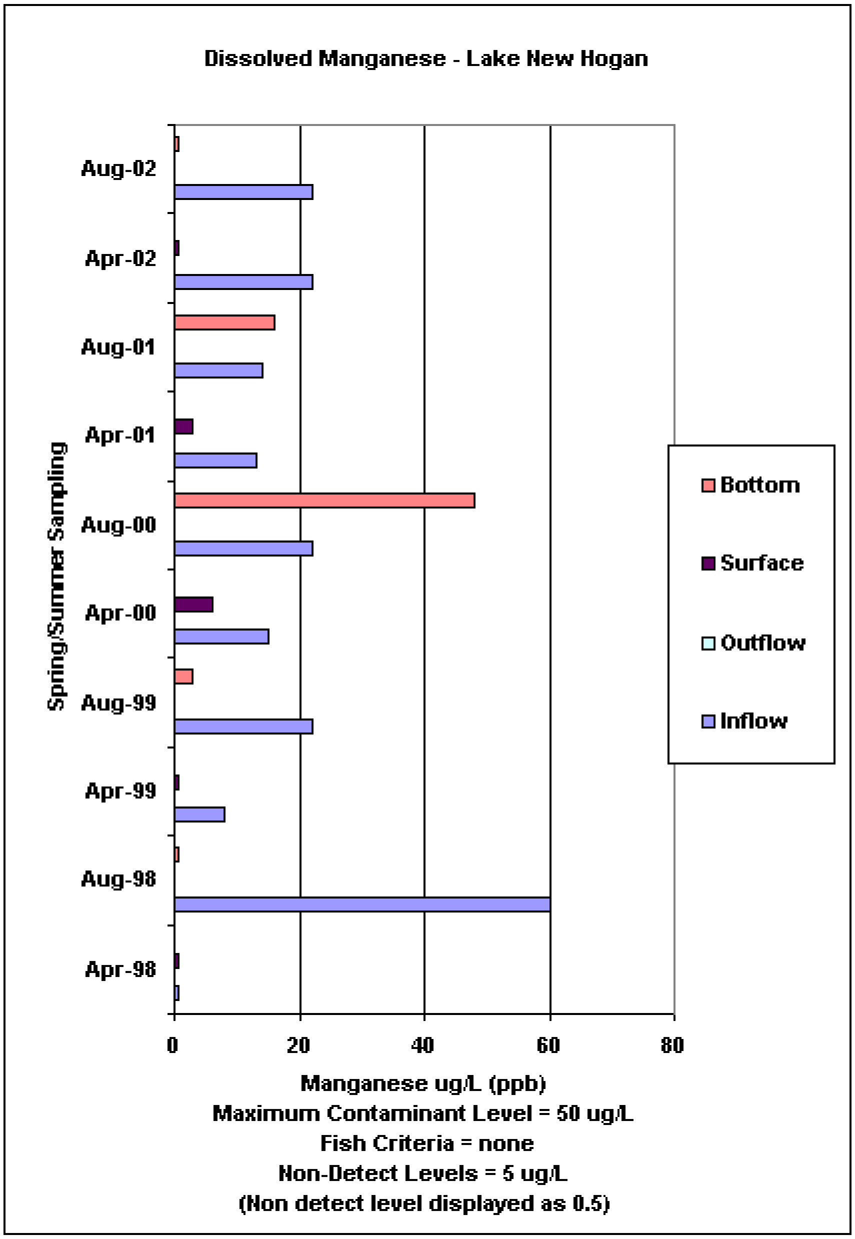

Dissolved Copper - Lake New Hogan
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
5
6
Bottom
Surface
Outflow
Inflow
Copper ug/L (ppb)
Maximum Contaminant Level = 1300 ug/L Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L
(ND levels displayed as 0.0625)

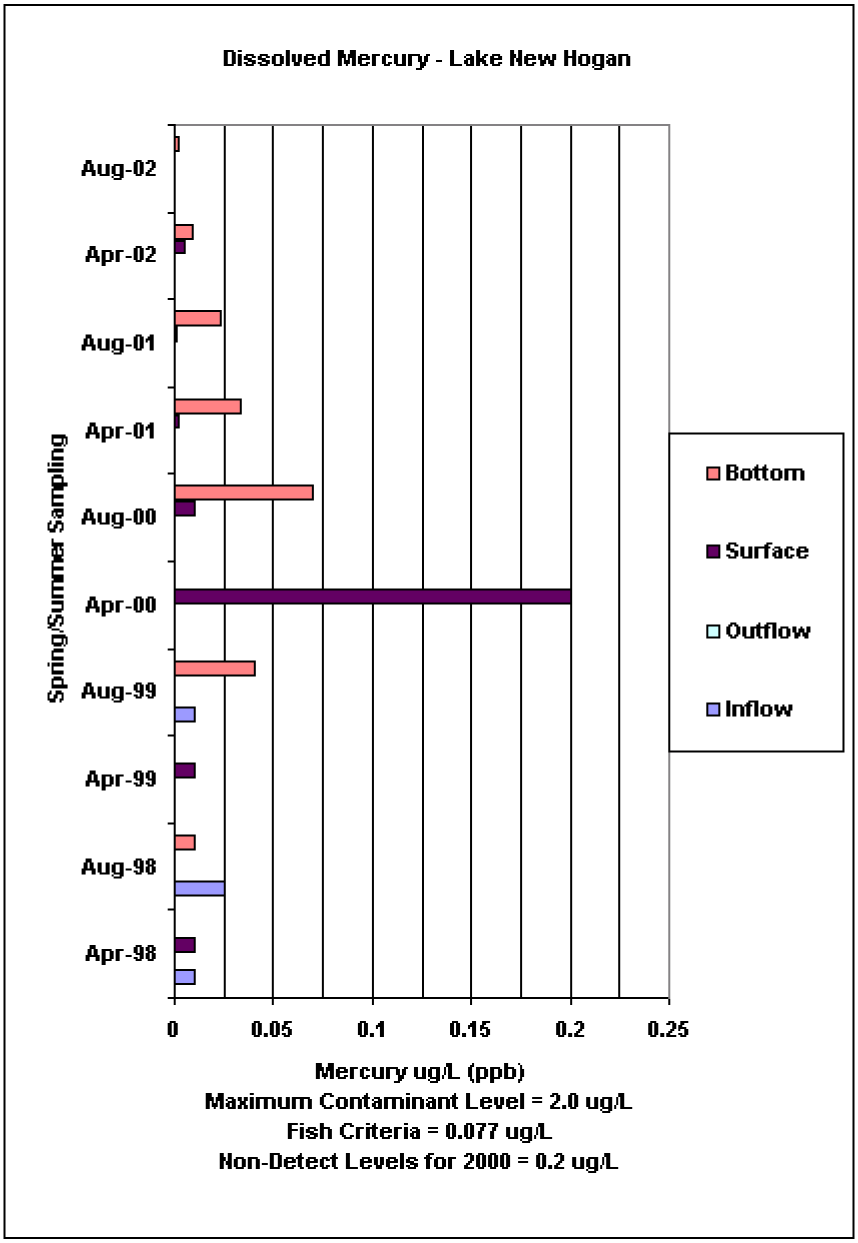


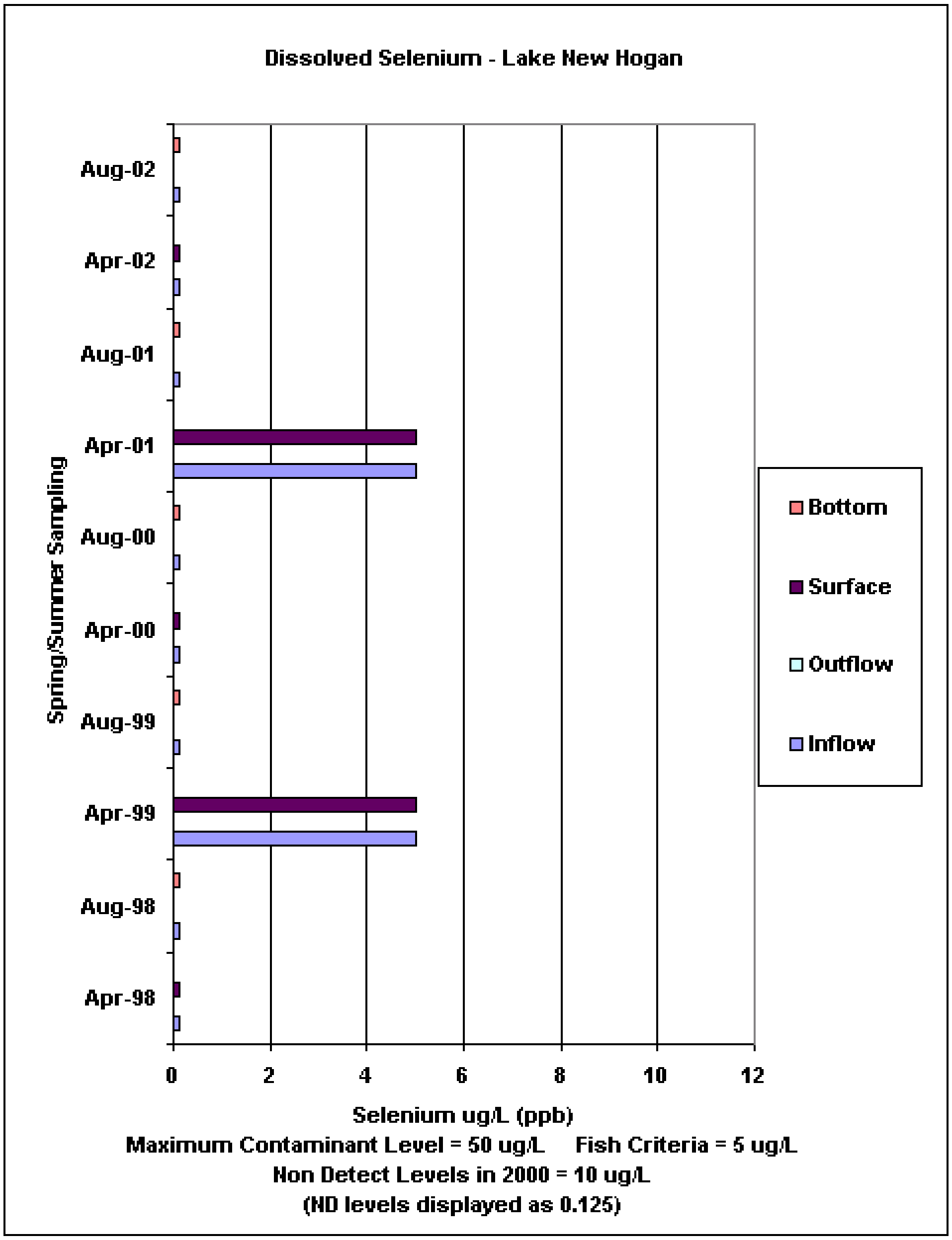
Maximum Contaminant Level = 300 ug/L   Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L   1999 and Beyond = 50 ug/L
(ND levels displayed as 5)



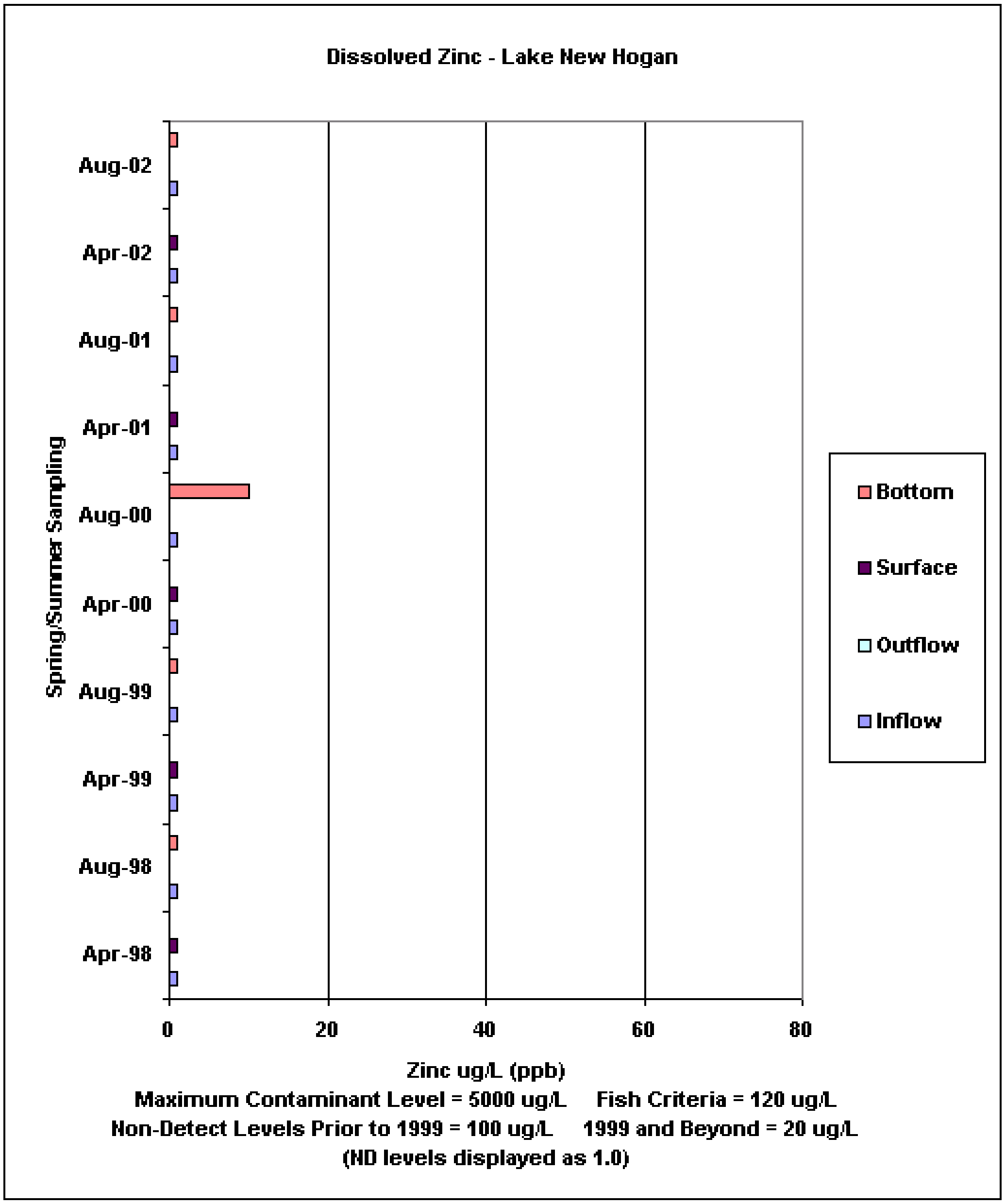
Dissolved Lead - Lake New Hogan
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
Bottom
Surface
Outflow
Inflow
Lead ug/L (ppb)
Maximum Contaminant Level = 15 ug/L Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L
(ND levels displayed as 0.0375)


Dissolved Manganese - Lake New Hogan
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
20
40
60
80
Bottom
Surface
Outflow
Inflow
Manganese ug/L (ppb)
Maximum Contaminant Level = 50 ug/L
Fish Criteria = none
Non-Detect Levels = 5 ug/L
(Non detect level displayed as 0.5)


Dissolved Mercury - Lake New Hogan
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
0.05
0.1
0.15
0.2
0.25
Bottom
Surface
Outflow
Inflow
Mercury ug/L (ppb)
Maximum Contaminant Level = 2.0 ug/L
Fish Criteria = 0.077 ug/L
Non-Detect Levels for 2000 = 0.2 ug/L



Dissolved Selenium - Lake New Hogan
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
10
12
Bottom
Surface
Outflow
Inflow
Selenium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L   Fish Criteria = 5 ug/L
Non Detect Levels in 2000 = 10 ug/L
(ND levels displayed as 0.125)



Dissolved Zinc - Lake New Hogan
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
20
40
60
80
Bottom
Surface
Outflow
Inflow
Zinc ug/L (ppb)
Maximum Contaminant Level = 5000 ug/L Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L 1999 and Beyond = 20 ug/L
(ND levels displayed as 1.0)

Appendix E: Inorganic Sample Data

Inorganic Results (mg/L) For surface lake waters (spring)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity		60	40	50	60	30	40	70	80	20		100
Ammonia		<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Chloride		21	2	21	4	4	3	<1	6	5		4
Nitrate		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1		<0.1
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Sulfate		5.3	2.6	4.2	8.9	2	1	8.2	9	2.1		4.7
Kjeldahl N		0.6	0.1	0.4	0.2	<0.1	0.3	0.2	0.2	0.2		<0.1
COD					<50							
Tot Solids		120	70	100	110	60	78	100	120	21		150

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	100	70	40	50	20	30	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	13	25	3	21	<1	<1	4	<1	6	4	3	2
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	
Sulfate	18	2.1	2.3	3	2.8	1.9	0.8	8.8	11	1.6	11	3.5
Kjeldahl N	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1
COD	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	170	130	59	110	60	60	90	110	150	30	130	90

Inorganic Results (mg/L) For surface lake waters (summer)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	140	70	40	50	50	40	70	90	80	10	80	110
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
Chloride	16	26	4	19	6	5	5	5	9	3	5	8
Nitrate	<0.1	1.5	<0.1	1.3	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1
Total P	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	16	4.1	3.6	3.5	5.9	2	0.7	7.4	14	1.6	6.4	4.4
Kjeldahl N	<0.1	2.7	<0.1	0.4	0.4	0.3	<0.1	0.2	<0.1	<0.1	0.2	0.6
COD	<50	60	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	200	190	50	120	98	80	80	120	120	52	100	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	90	40		60	40	80	100	130	20	110	180
Ammonia												
Chloride	16	490	5		10	8	3	5	14	4	5	22
Nitrate												
Total P												
Ortho P												
Sulfate	16	4.5	3		9.8	3.2	<0.5	6	14	2.7	5.4	8.7
Kjeldahl N												
COD												
Tot Solids	200	1300	50		140	100	100	150	200	50	140	280

Appendix F: MTBE Table

2002 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2002 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	2		2		<2		<2		
Eastman	5				<2				
Englebright	3		3		10		10	10	
Hensley	3		3		3		3		
Isabella	<2	<2	<2	<2	<2	<2	<2	<2	
Kaweah	2		2	<2	8		6	6	
Martis Cr.	<2				<2				
Mendocino	<2				<2				
New Hogan	<2				3				
Pine Flat	<2		<2		2		2		
Sonoma		3	<2		<2		2		
Success	4		4	4	11	12	11	11	

Notes:

1. Non-Detect is indicated by "<2" since the Reporting Limit is 2 ppb or 0.002 ppm.

2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.

3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.

4. For 2002, the number of MTBE water sampling at each lake is based on last year's lab results.

5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was historically non-detectable. The 2002 results of non-detectable levels were similar except Lake Eastman and New Hogan now reported low, detectable levels of MTBE.

6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because of historically low detectable levels of MTBE.

7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because of historically higher MTBE being found. The 2002 results were similar except Isabella now reported non-detectible levels.

8. In 2001, very high MTBE levels were reported at Lake Isabella during the Spring (18 ug/L near the marina) . During Spring 2000, Lake Isabella reported 21 ug/L. The 2002 results indicate that the previous MTBE problem near the marina was not visible during the Spring 2002 sampling event, and may have been rectified.

Appendix G: Fish Tissue Analysis Table

2002 Fish Tissue Results

The following table provides an overview of the lab results for the 2002 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conducting the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The California OEHHA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Mercury Total ppm	FDA Criteria
Black Butte	Sm M Bass	Composite (3)	6/12/02	0.24	0.26	1 ppm
Eastman	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Englebright	Note 5	N/A	N/A	N/A	N/A	
Hensley	Black Bass	Composite (3)	4/23/02	<0.10	0.72	1 ppm
Isabella	Black Bass	Composite (3)	6/4/02	0.20	0.21	1 ppm
Kaweah	Sm M Bass	Composite (3)	7/14/02	0.11	0.53	1 ppm
Martis Cr	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Mendocino	Note 6	N/A	N/A	N/A	N/A	
New Hogan	Lg M Bass	Single (1)	6/3/02	<0.10	0.34	1 ppm
Pine Flat	Note 4	--------------------	-----------	----------	-----------	< Mon 01
Sonoma	Note 6	N/A	N/A	N/A	N/A	
Success	Black Bass	Composite (3)	4/15/02	<0.10	0.18	1 ppm

Notes:

9. Non-Detect is indicated by "<0.02". The lab Detection Limit for mercury is 0.02 ppm.
10. Total Mercury was reported in mg/g or ppm.
11. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.
12. The fish tissue program was terminated at Eastman and Martis Creek in 2001 and in Pine Flat in 2002 due to low total mercury results. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout). For Pine Flat total mercury was 0.21 ppm in 2000 (composite of three Sacramento Sucker fish) and 0.23 in 2001 (composite of three spotted bass).

13. Due to seasonal conditions, a fish could not be successfully collected at Lake Englebright. Another attempt will be accomplished for the 2003 report.
14. Fish were not collected at Mendocino or Sonoma due to communication difficulties.

The above 2002 total mercury results indicate only Hensley is higher than average. However, in 2001, the total mercury results were only 0.30 ppm for Hensley (small mouth bass). The 2003 fish tissue program should provide additional data. EPA fact sheet on fish advisories (EPA-823-F-99-016) indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.

Annual Water Quality Report

PINE FLAT LAKE

Water Year 2002

Written by
John J. Baum
Water Quality Engineer
U. S. Army Corps of Engineers
Sacramento District
January 2003

TABLE OF CONTENTS

Pine Flat Lake

I. Purpose

This report is part of an environmental monitoring program that began at Pine Flat Lake in April 1980. The monitoring program was implemented to both ensure a continuous level of water quality in the lake for recreation and environmental health and to satisfy the Department of Army Engineering Regulation 1110-2-8154, “Water Quality and Environmental Management for Corps Civil Works Projects”.

II. Brief Description of Pine Flat Lake

Pine Flat Lake is located in central California, 3 miles east of Fresno. It is nestled in the Sierra Nevada foothills and is surrounded by grasslands and blue oaks. At maximum capacity, the lake has 11,400 surface acres and holds 1,000,000 acre-feet of water. The lake was created by the construction of Pine Flat Dam on the Kings River. The 429-foot dam was completed in 1954. A hydroelectric plant associated with the dam was completed in 1984. Since being built for flood control and irrigation, the lake has become a popular destination for recreation.

Water quality monitoring by the United States Army Corps of Engineers (USACE) began at Pine Flat Lake in April 1980. Generally there are two sample events a year, spring (April) and late summer (August). Since the start of the monitoring program, a water quality report is produced yearly to list results and address any concerns of the previous water year.

Generally, Pine Flat Lake has a depth of greater than 100 feet during the sampling events and is considered a mesotrophic lake when characterized by its clarity. A mesotrophic lake is one that has qualitites in between an oligotrophic (clear and nutrient limited, example Lake Tahoe) and a eutrophic lake (low clarity and high in nutrients, example Clear Lake). Pine Flat Lake can have low dissolved oxygen conditions (<5 mg/L) at its bottom depths during warm late summer months. While the water in Pine Flat Lake is deep and cool during the spring, the lake can be shallow and warm (>20ºC) in the late summer. Due to the high late summer temperatures, the lake is best suited for warmwater fish species. Warmwater fish species include bass, carp, perch, bluegill, crappie, and catfish. Although clearer than eutrophic (nutrient rich) lakes, mesotrophic lakes also can have low water clarity due to algal blooms and wind suspended sediments in shallow areas. Water clarity is often measured in terms of Secchi Disc depth or SD (Appendix A). Historically the water clarity in Pine Flat Lake is good with only ~7 % of the samples not meeting the recreational goal of 4 feet or greater (Figure 1). In 2001 the Spring SD measure was 26.58 feet and the late summer sample SD value was better at 6.17 feet.

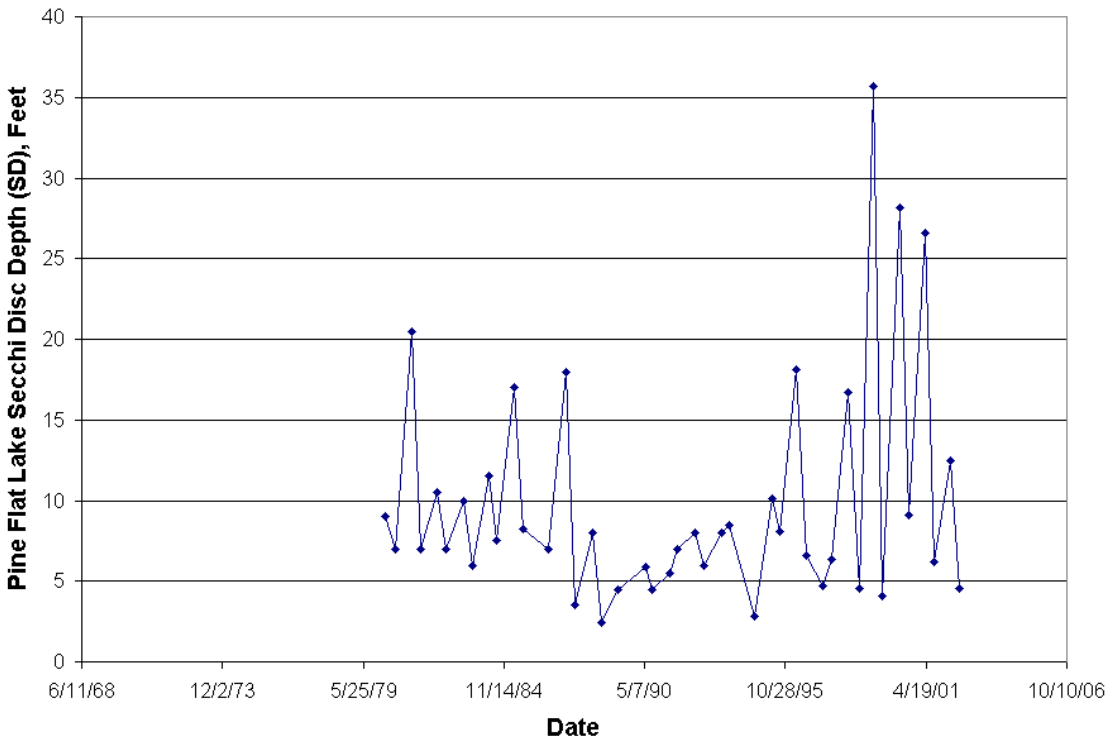


Figure 1. Historical Secchi Depth Values at Pine Flat Lake (2002 values included).

The 2001 Water Quality Report listed several contaminants of concern at the bottom of Pine Flat Lake. The contaminants of concern were dissolved metals (chromium, manganese, and iron). These contaminants will be examined in this 2002 water quality report.

III. Sample Summaries for this year.

Introduction

The following general summaries are split into their respective sample types. Each type of sample summary includes a discussion of both the spring (April) and late summer

(August) samples to better examine trends within the current year. The types of parameters monitored this year include: Secchi Disc depths, water column profiles (temperature, DO and pH), phytoplankton characterization, metals concentrations, MTBE concentrations, and Inorganic characterization (alkalinity, phosphorous, nitrogen, etc..). Fish mercury concentrations are no longer monitored at Pine Flat Lake due to finding low concentrations in fish during previous years. For a more detailed explanation of the importance for each type of sample, please see Appendix A.

SECCHI DEPTH

The Secchi Disc depth found during the spring and late summer sampling were lower than the historical average (historical mean SD = 9.83 feet). More often the clarity is better in the spring than in late summer. In spring the water clarity was high and the SD was 12.5 feet, which was less than the previous year (2001 spring SD = 26.58 feet). The late summer SD of 5.33 feet was above the recreational goal of 4 feet and but was less than the previous year (summer 2001 SD = 6.17) (Appendix B).

TEMPERATURE VALUES

The temperature profiles for Pine Flat Lake are indicative of a seasonally stratified lake. The lake is stratified in the spring, but the bottom layer (hypolimnion) disappears by the warm temperatures of late summer due to evaporation and discharging. The difference in the depth of the lake between the spring and late summer sampling events was large (spring depth = 295 feet, late summer depth= 144.4 feet). Additionally, the average temperatures were very different (spring average temp. = 10.16 ºC, late summer average temp.= 22.04 ºC). Pine Flat Lake is unable to regulate its temperature year-round because it was without a deep-water area to buffer it from the warm summer air temperatures. Due to the warmth of the water, Pine Flat Lake would best be suited to support warmwater fish species. For detailed results obtained during the sampling events, please see Appendix B.

DISSOLVED OXYGEN

The dissolved oxygen (DO) concentration differs greatly from spring to late summer. In spring, DO concentrations are 10.80 mg/L near the surface and 9.10 mg/L at the bottom of the lake. DO concentrations near the surface are above saturation, which is 9.42 mg/L at 18.2 ºC. Elevated dissolved oxygen concentrations near the surface are associated with phytoplankton photosynthesis. DO concentrations in the late summer are much lower and vary through the water column. During the summer the DO concentration near the surface was 5.06 mg/L and lowered towards the bottom of the lake to a minimum of 1.81 mg/L. The lower DO values at the bottom of the lake are associated the decomposition of waste materials. Fish species that require greater than 5 mg/l DO and cooler water temperatures (< 20ºC) may be able to survive year-round at Pine Flat Lake. For detailed results obtained during the sampling events, please see Appendix B.

PH LEVELS

In the spring sample event pH values in the lake were slightly basic (pH = ~7.6) throughout the water column. The pH values in the late summer profile varied widely.

The pH was basic toward the upper waters (max pH = 9.17) and slightly acidic at the bottom (pH bottom = 6.96). The lower pH values at the bottom of the lake increase the likelihood that higher soluble metal concentrations will be seen. For detailed results obtained during the sampling events, please see Appendix B.

PHYTOPLANKTON

In spring 2002, the algal biomass within the lake was much higher (Biomass = 3382.04 ug/L) compared to spring 2001 (2001 Spring biomass = 41.44 ug/L). In spring 2001 cryptomonads were the most dominants species and in spring 2002 diatoms were the most dominant. In late summer the same trend occurred and the phytoplankton population was much higher in summer 2002 (2002 Summer Biomass = 8532.68 ug/L) than summer 2001 (2001 Summer Biomass = 511.65 ug/L). Blue-green algae were the most dominant species during the 2002 and 2001 late summer sampling events. While most phytoplankton species must obtain nitrogen (a required nutrient for growth) from aqueous forms in the lake, blue-green algae have the ability to use the atmospheric form or nitrogen gas (nitrogen fixation). In lakes that are limited in nitrogen availability, nitrogen fixing is a distinct advantage. Blue-green algae is often thought of as a nuisance due to the inability of it to be used in the aquatic food chain and for its impact on water clarity. For detailed results obtained during the 2002 sampling events, please see Appendix C.

METALS

None of the dissolved heavy metal samples exceeded the maximum contaminant level (MCL) or the freshwater fishery criteria during either the 2002 spring and summer sampling events. While there were detectable concentrations of manganese and iron, the elevated values seen in 2001 were not repeated. Contaminants will continue to be monitored in the coming year for any changes. For detailed results obtained during the sampling events, please see Appendix D.

MTBE

Concentrations for MTBE around the lake were found to be at or below the detection limit (< 2 ppb) during both spring and late summer sampling events. Due to its low concentrations, MTBE is not seen as a contaminant of concern. For detailed results obtained during the sampling events, please see Appendix F.

INORGANIC ANALYSIS

The spring and summer sample results were within expected ranges and levels. The only result to note was the low alkalinity concentrations(Spring Alkalinity = 20 mg/L $CaCO_3$, Summer Alkalinity = 10 mg/L $CaCO_3$) in the lake. The summer 2002 lake alkalinity was the lowest of all of the lakes monitored by the USACE. For detailed results obtained during the 2002 sampling events, please see Appendix E.

IV. Conclusions

Pine Flat Lake is a seasonally deep mesotrophic lake that can comfortably support warmwater fish species. Coldwater fish that require temperatures below 20°C and dissolved oxygen concentrations greater than 5 mg/L could survive in the lake assuming moderate summer weather conditions. Water clarity in Pine Flat Lake during the 2002 sampling events was above 4 feet.

In the 2002 Pine Flat Lake sampling events, no contaminants of concern were found to exceed either the MCL or aquatic organism health limits. Historically dissolved metals (manganese and iron) have been seen in elevated levels in Pine Flat Lake and will continue to be monitored.

V. References

North American Lake Management Society (1990). *Lake and Reservoir Restoration Guidance Manual*, EPA 440/4-90-006, U.S. Environmental Protection Agency, Washington, DC.

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VI. Appendices

Appendix A: Glossary of Sample Types

Glossary of Sample Types

This glossary of sample types is intended to provide a general background and indicate the importance of each sample in determining water quality. These are meant to be brief and basic. If a further explanation is desired please refer to the list of references provided in this report.

Secchi Depth

One of the oldest and easiest methods to determine lake clarity is the Secchi depth (SD). The Secchi depth is determined by dropping a Secchi disc into a water body and determining the depth that it is last visible from the surface of the water. Secchi discs are generally white and 20 cm in diameter. Secchi depth values are most impacted by the light intensity at the time of sampling and the scattering of light by solid particulates within the water column. Algal growth (phytoplankton) and sediment re-suspension are often major constituents of solid particulates within the water column. Secchi depth values can be used to estimate the Trophic state or the nutrient levels within the lake. The more nutrients are available, the larger likelihood of algal blooms that limit water clarity. Due to recreational concerns for safety, the goal for Secchi depth values is four feet or greater.

Temperature Profiles and Data Points

The temperature profile of a lake provides information how a lake is operating and the potential for aquatic biota to live within the lake. The temperature profile is a direct indicator if a lake is stratified. Stratification in lakes is created generally by temperature affecting the density of water molecules. Stratification is usually indicated by a region of similar temperature nearer the surface of the water (epilimnion), then a region of temperature transition (metalimnion), to another layer of nearly constant temperature at the bottom of the lake (hypolimnion). Each layer in a stratified lake is important, but the existence of a hypolimnion can drastically impact how well a lake can handle warmer temperatures such as those found in northern California during the summer. The hypolimnion acts as a buffer against large temperature shifts. The nature of dam operation is that water is discharged near the bottom, releasing the hypolimnion, and eliminating stratification. This operation limits the ability of reservoirs to regulate their temperature during the summer months. Stratification isn't always desirable. When a lake isn't stratified and is instead well mixed, the required nutrients near the bottom of the lake become available to phytoplankton for growth. Temperatures within lakes also indicate which species of fish will survive within a lake. Coldwater species of fish require temperatures below 20 degrees C in order to spawn and survive. If a lake is often above 20 degrees C, then only warmwater fish species will survive.

Dissolved Oxygen (DO) Concentration Profiles

DO is required by organisms for respiration and for chemical reactions within lake waters. The recommended level for DO for most aquatic species survival is 5mg/L. In lakes, biota waste (detritus) falls to the bottom of the lake to be utilized by bacteria. The bacteria need oxygen and will deplete levels near the bottom of a lake, especially during

warm temperature, high respiration conditions. For nutrient rich (eutrophic) lakes more organisms will grow, create wastes, and cause oxygen depleted regions at the lowest areas. Under these conditions only aquatic species that can survive low DO conditions in warm water near the surface will survive.

PH Profiles

The pH profiles of the lakes indicate the potential for certain chemical reactions to occur. In high pH (greater than pH = 7 or basic) aquatic systems, metal pollutants tend to form into insoluble compounds that fall onto the lake floor. In low pH (less than pH = 7 or acidic) systems or areas metal ions become soluble and available for uptake into aquatic organisms. Other compounds like ammonia that are introduced into a low pH aquatic environment will transform into soluble nitrate and be utilized by organisms.

Phytoplankton Analysis

Phytoplankton analysis indicates the health, nutrients, and biodiversity within a lake. Lakes that have few nutrients available (Oligotrophic) will generally have a much lower quantity of phytoplankton (high Secchi depth) but the number of phytoplankton species seen will be large. In a lake that is nutrient rich (eutrophic) there are generally large phytoplankton blooms (low Secchi depth), but they are made up of a couple of phytoplankton species. Certain species of phytoplankton are preferred food sources for zooplankton (small invertebrates). Generally species like diatoms and green algae can be consumed by the filter-feeding zooplankton, but species like bluegreen algae are low in nutrients and are difficult to consume. Some species like the dinoflagellates can grow horn like points to discourage potential predators. In nutrient rich waters where there is plenty of phosphorous, nitrogen can be limited for biological growth. While most species can't grow due to the lack of nitrogen, bluegreen algae (cyanobacteria) have the ability to utilize nitrogen from the atmosphere when required. This gives bluegreen algae the ability to dominate in many eutrophic lakes.

Soluble Metals Analysis

The soluble metals analysis indicates the exposure of humans and aquatic organisms to toxic metals. These metals often build up as they are consumed through the food chain. Water samples provide an indicator for additional problems. Soluble forms of metal ions are more prevalent in low pH (pH <7, or acidic) environments.

MTBE Analysis

MTBE (methyl tertiary-butyl ether) is a chemical additive to gasoline to improve combustion. Due to its high solubility, MTBE travels and blends into aquatic systems rapidly. While not found to be extremely hazardous at low levels, the offensive smell and taste is detectible by humans at extremely low concentrations. The effect of MTBE on humans and aquatic systems is still under investigation.

Inorganic Analysis

Alkalinity

Alkalinity is measured in terms of mg/L of calcium carbonate. It indicates a lakes ability to buffer incoming acidic pollution and situational changes.

Ammonia

Ammonia is a gas that is toxic to fish and is more visible at a higher pH. Ammonia is created through anthropogenic inputs, bacteria cell respiration, and the decomposition of dead cells. Due to being a gas, given time ammonia will volatilize from the water. At a lower pH, much of the ammonia is converted to ammonium (a nutrient for root bound plant life) and utilizes DO in the nitrification process.

Chloride

The chloride ion is an indicator of any salinity increases within a lake. Most fresh water aquatic species are sensitive to salinity changes.

Nitrate

Nitrate is the nitrogen product created through the nitrification of ammonium. Nitrate is a soluble form of the nutrient nitrogen and is utilized by phytoplankton.

Total Phosphorous

The total phosphorous provides a measure of both utilized and soluble phosphorous within water samples. Phosphorous is a required nutrient for plant growth and development.

Ortho Phosphorous

Ortho phosphorous is the soluble form of phosphorous that is utilized by free-floating aquatic plants (phytoplankton).

Kjeldahl N

Kjeldahl nitrogen or total Kjeldahl nitrogen (TKN) is a measure of the total concentration of nitrogen in a sample. This includes ammonia, ammonium, nitrite, nitrate, nitrogen gas, and nitrogen contained within organisms.

COD

Chemical Oxygen Demand (COD) is a measure of the total oxygen required to complete the chemical and biological demands of a sample.

Fish Tissue Analysis

Fish tissue is analyzed to examine potential exposure of humans to toxicants as well as the health of the aquatic food chain. In aquatic systems toxic contaminants can build up (or bioaccumulate) within animals at the top of the food chain. Contaminants (especially organic pollutants) are retained within the fat tissue of an organism, therefore in fish samples the lipid content is often measured.

Lake Code Designation

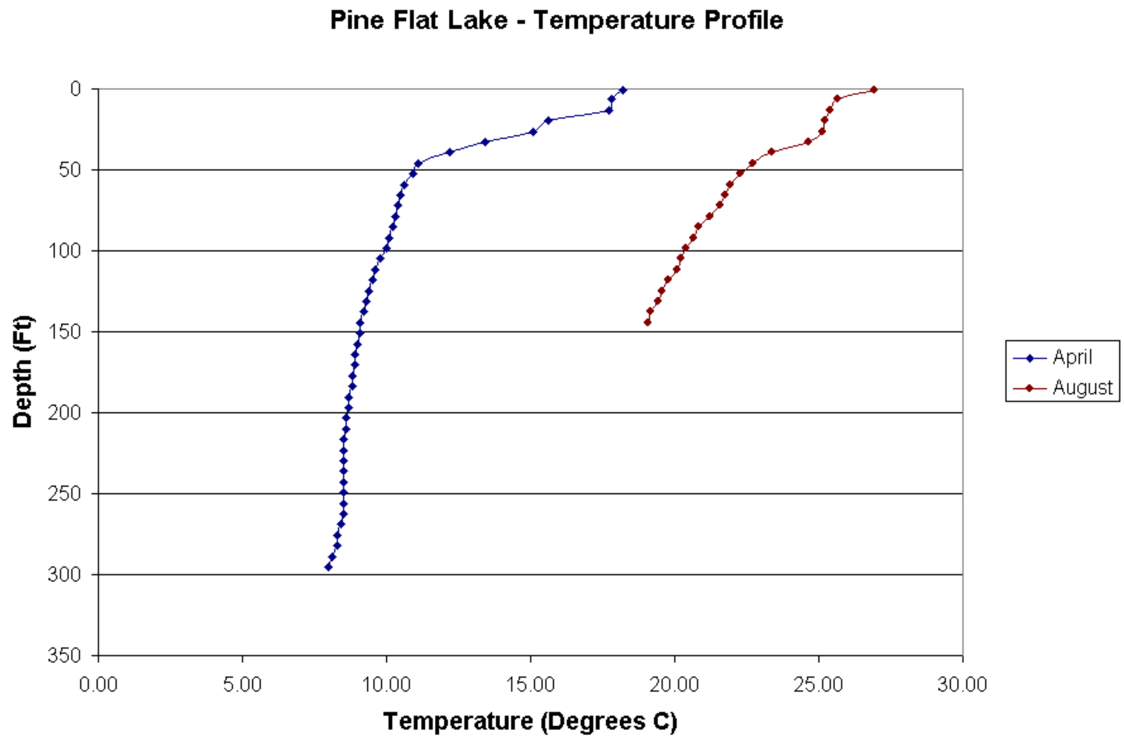
Laboratory Reports are provided in the previous sections.

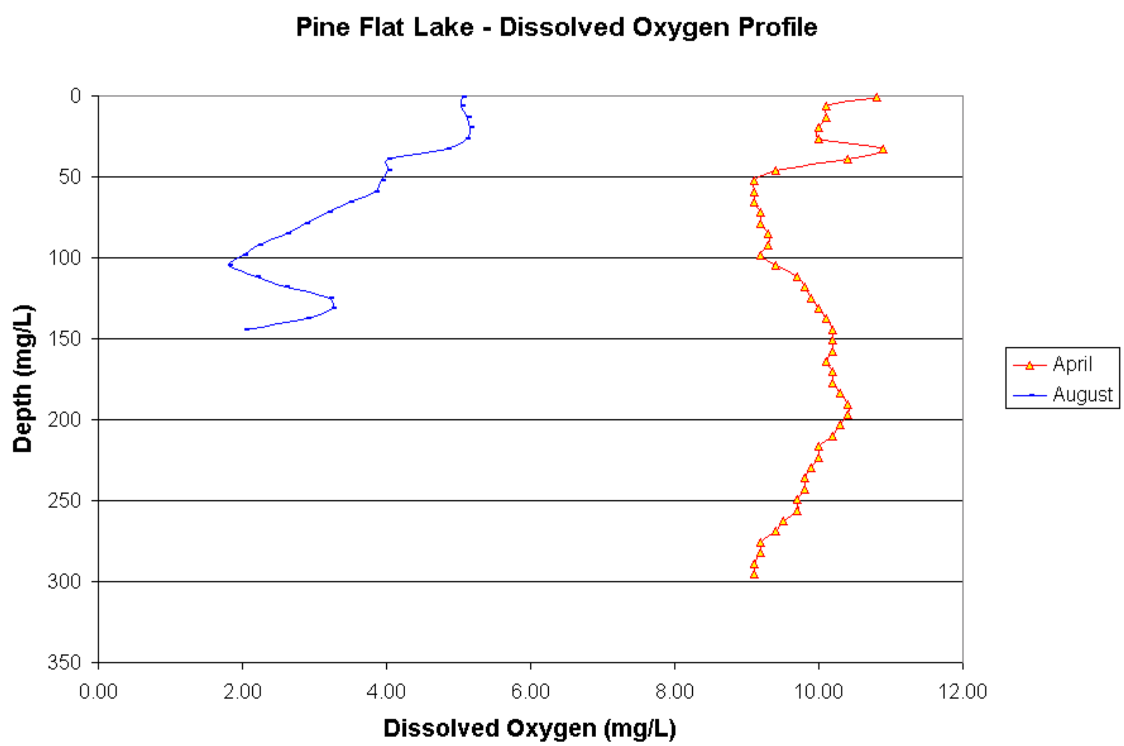
Sample ID is "XX-YY-ZZ" where

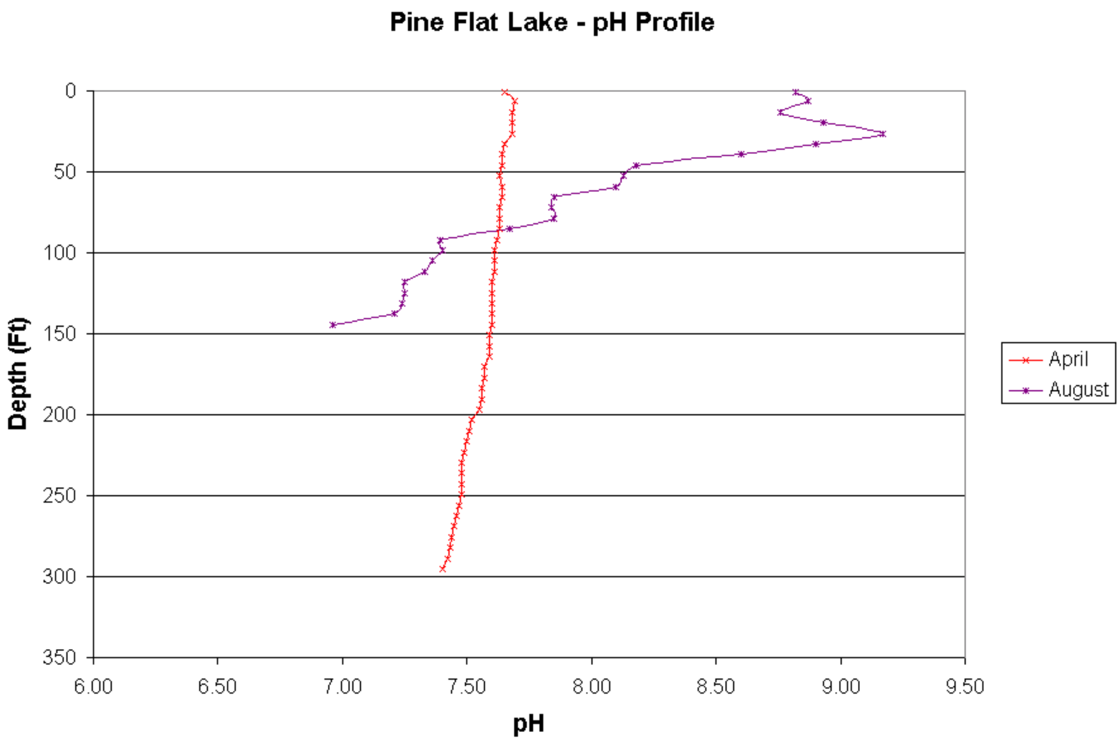
XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summar	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

Example: BB-SU-S is for a water sample taken from Black Butte in the Summer on the Lake's Surface.

Appendix B: Profile Data and Charts (Secchi Disc, Temperature, DO, and pH)


Pine Flat Lake - Temperature Profile
Depth (Ft)
Temperature (Degrees C)
0
50
100
150
200
250
300
350
0.00
5.00
10.00
15.00
20.00
25.00
30.00
April
August


Pine Flat Lake - Dissolved Oxygen Profile
Depth (mg/L)
Dissolved Oxygen (mg/L)
0
50
100
150
200
250
300
350
0.00
2.00
4.00
6.00
8.00
10.00
12.00
April
August

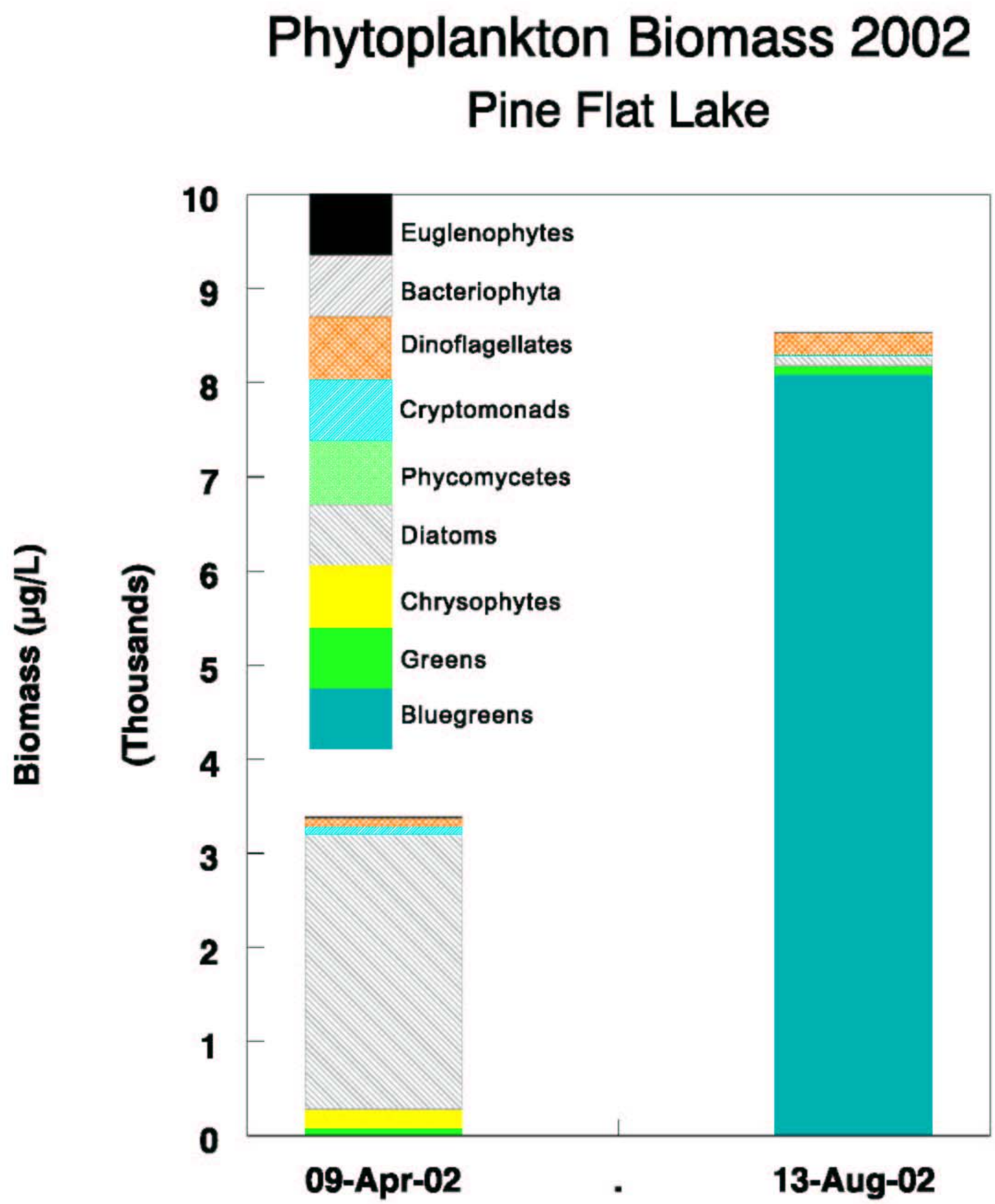

Pine Flat Lake - pH Profile
Depth (Ft)
0
50
100
150
200
250
300
350
6.00
6.50
7.00
7.50
8.00
8.50
9.00
9.50
pH
April
August

PINEFLAT					
Sample Location: Behind dam				**Date:** 04/09/02	
Observers: Tim McLaughlin				**Time:** 10:30 am	
Lake Elevation: 845.31					
Weather Conditions					
Wind Speed (mph): 0		**Precipitation:** 0		**Temp (F):** 70	
SECCHI Depth: 12 feet and 6 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
89.1	295.3	8.00	52	9.10	7.40
88	288.7	8.10	46	9.10	7.42
86	282.2	8.30	42	9.20	7.43
84	275.6	8.30	43	9.20	7.44
82	269.0	8.40	41	9.40	7.45
80	262.5	8.50	41	9.50	7.46
78	255.9	8.50	41	9.70	7.47
76	249.3	8.50	42	9.70	7.48
74	242.8	8.50	44	9.80	7.48
72	236.2	8.50	43	9.80	7.48
70	229.7	8.50	43	9.90	7.48
68	223.1	8.50	42	10.00	7.49
66	216.5	8.50	42	10.00	7.50
64	210.0	8.60	42	10.20	7.51
62	203.4	8.60	42	10.30	7.52
60	196.6	8.70	42	10.40	7.55
58	190.3	8.70	42	10.40	7.56
56	183.7	8.80	42	10.30	7.56
54	177.2	8.80	42	10.20	7.57
52	170.6	8.90	42	10.20	7.57
50	164.1	8.90	42	10.10	7.59
48	157.5	9.00	42	10.20	7.59
46	150.9	9.10	42	10.20	7.59
44	144.4	9.10	43	10.20	7.60
42	137.6	9.20	43	10.10	7.60
40	131.2	9.30	42	10.00	7.60
38	124.7	9.40	42	9.90	7.60
36	118.1	9.50	42	9.80	7.60
34	111.5	9.60	42	9.70	7.61
32	105.0	9.80	42	9.40	7.61

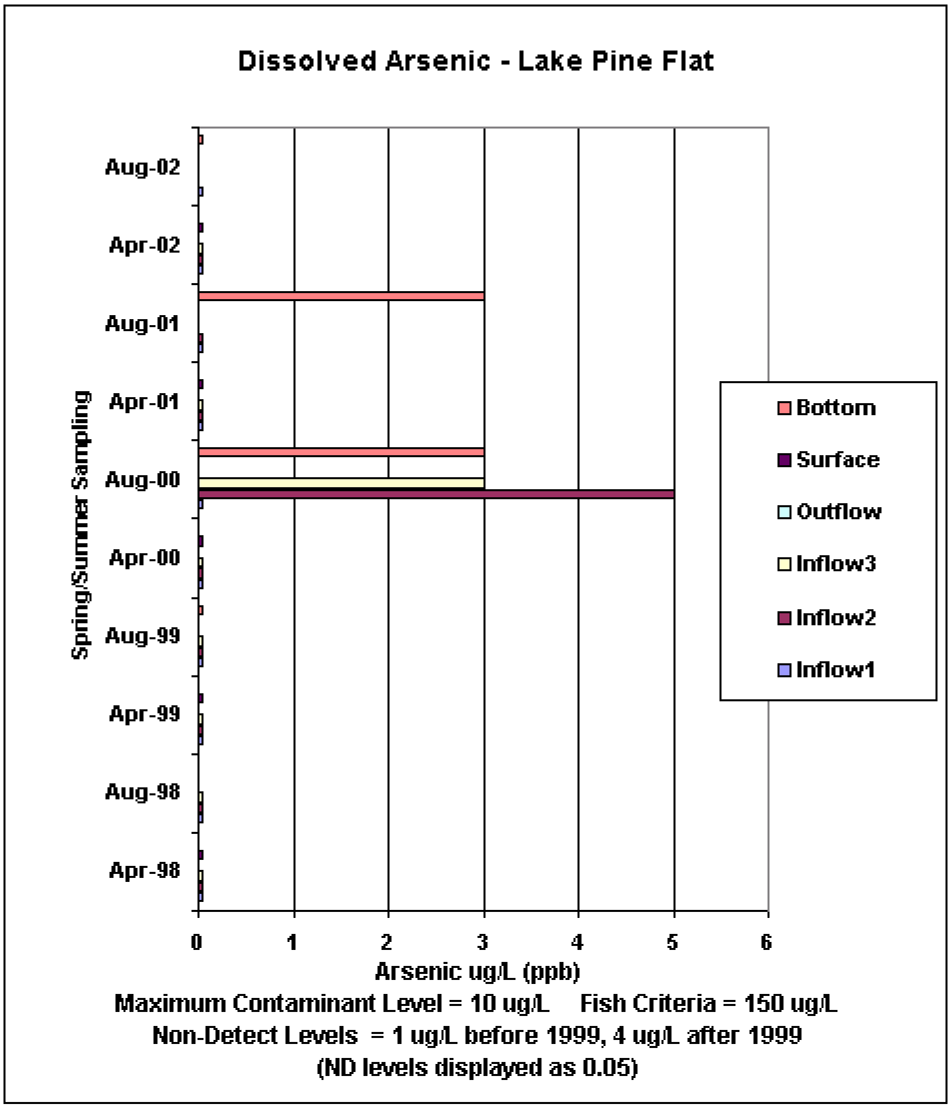
PINEFLAT					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
30	98.4	10.00	42	9.20	7.61
28	91.9	10.10	41	9.30	7.62
26	85.3	10.20	41	9.30	7.63
24	78.7	10.30	41	9.20	7.63
22	72.2	10.40	41	9.20	7.63
20	65.6	10.50	41	9.10	7.64
18	59.1	10.60	41	9.10	7.64
16	52.5	10.90	41	9.10	7.63
14	45.9	11.10	40	9.40	7.64
12	39.4	12.20	41	10.40	7.64
10	32.8	13.40	40	10.90	7.65
8	26.2	15.10	40	10.00	7.68
6	19.7	15.60	40	10.00	7.68
4	13.1	17.70	39	10.10	7.68
2	6.6	17.80	38	10.10	7.69
0.03	1	18.20	38	10.80	7.65
KINGS (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
56.7	7.12		-	-	-

PINEFLAT					
Sample Location: Behind dam				Date: 8/13/02	
Observers: Tim McLaughlin				Time: 10:00 am	
Lake Elevation: 733.44					
Weather Conditions					
Wind Speed (mph): 5		Precipitation: 0		Temp (F): 80	
SECCHI Depth: 4 feet and 7 inches					
Depth-M	Depth-F	Temp-C	Cond	DO mg/L	pH
43	144.4	19.07	26	2.04	6.96
42	137.6	19.16	26	2.90	7.21
40	131.2	19.43	25	3.25	7.24
38	124.7	19.56	25	3.21	7.25
36	118.1	19.78	26	2.59	7.25
34	111.5	20.07	27	2.20	7.33
32	105.0	20.22	31	1.81	7.36
30	98.4	20.40	32	2.02	7.40
28	91.9	20.65	33	2.23	7.39
26	85.3	20.83	35	2.61	7.67
24	78.7	21.23	32	2.88	7.85
22	72.2	21.56	32	3.20	7.84
20	65.6	21.75	31	3.49	7.85
18	59.1	21.93	29	3.84	8.10
16	52.5	22.30	29	3.93	8.13
14	45.9	22.73	30	4.01	8.18
12	39.4	23.39	31	4.02	8.60
10	32.8	24.63	32	4.84	8.90
8	26.2	25.13	36	5.10	9.17
6	19.7	25.20	37	5.15	8.93
4	13.1	25.41	37	5.13	8.76
2	6.6	25.67	38	5.04	8.87
0.03	1	26.93	37	5.06	8.82
KINGS (Inflow)					
Temp (F)	pH		DO mg/L	EC	Flow rate (cfs)
78.5	8.66		-	-	-
SYCAMORE CREEK (Inflow) - DRY					
Temp (F)	pH		DO mg/L	EC	Flow rate (cfs)
-	-		-	-	-
BIG CREEK (Inflow) - DRY					
Temp (F)	pH		DO mg/L	EC	Flow rate (cfs)
-	-		-	-	-
VISUAL OBSERVATIONS:					

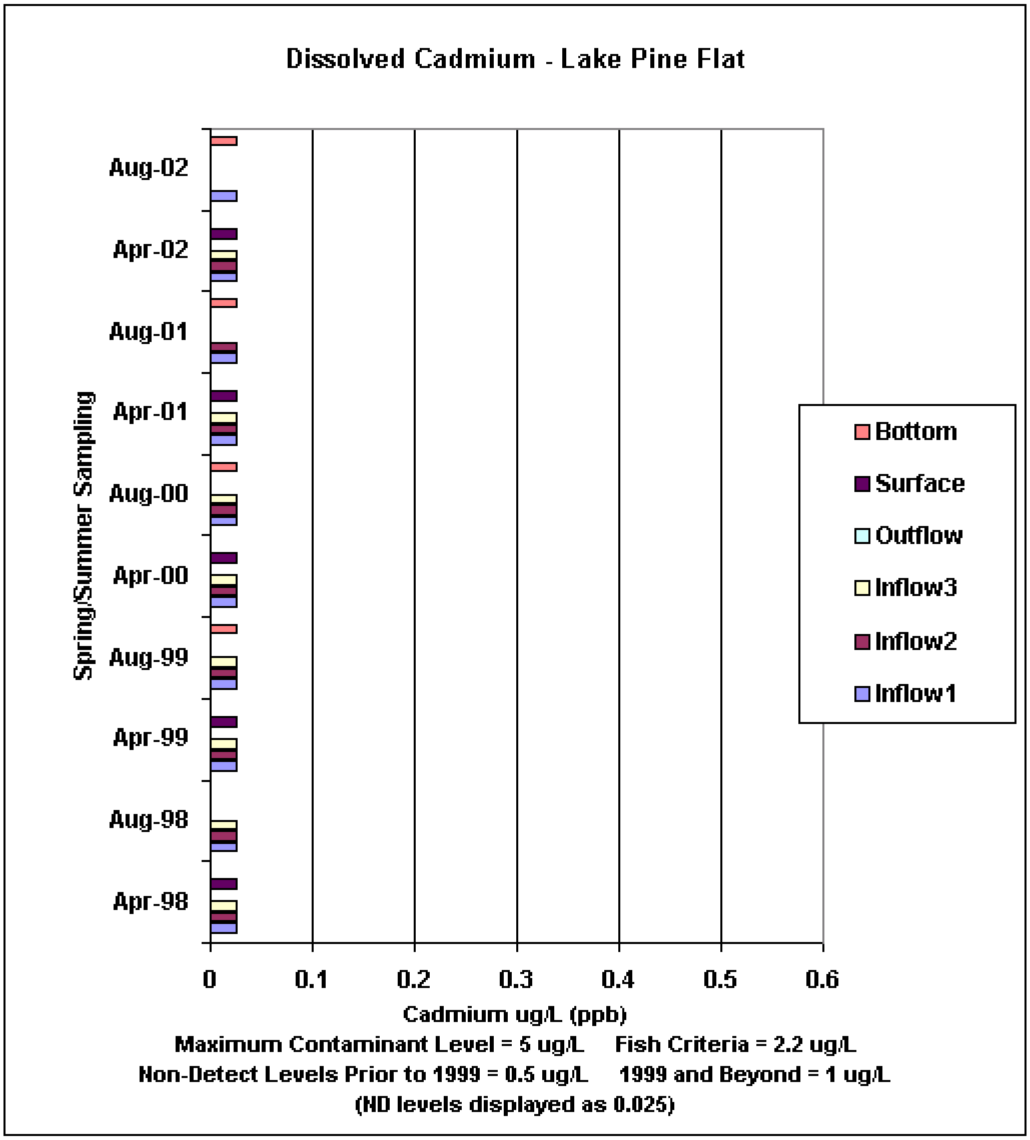
Appendix C: Phytoplankton Data and Charts


Phytoplankton Biomass 2002
Pine Flat Lake
Biomass (µg/L)
(Thousands)
10
9
8
7
6
5
4
3
2
1
0
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
09-Apr-02
.
13-Aug-02

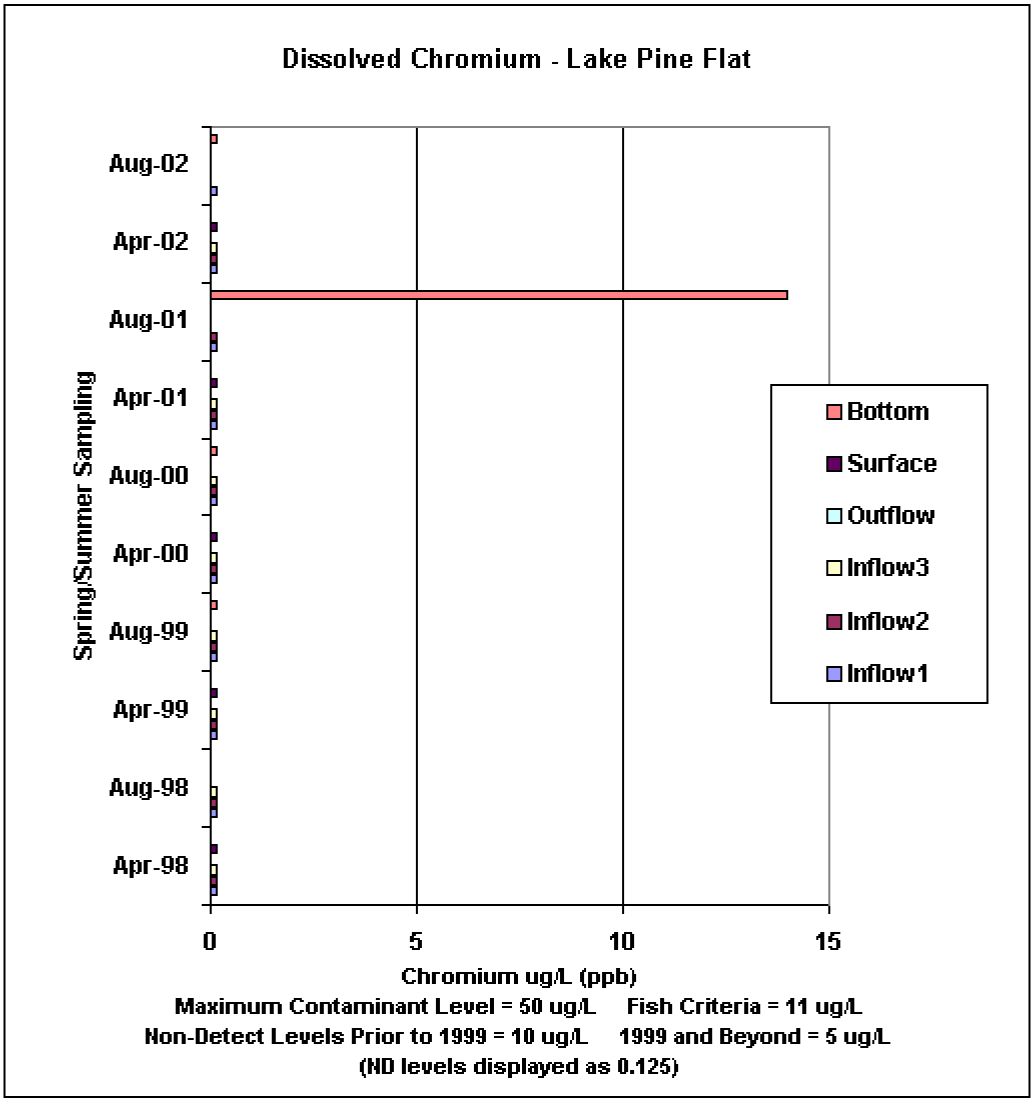
Appendix D: Metals Data and Charts

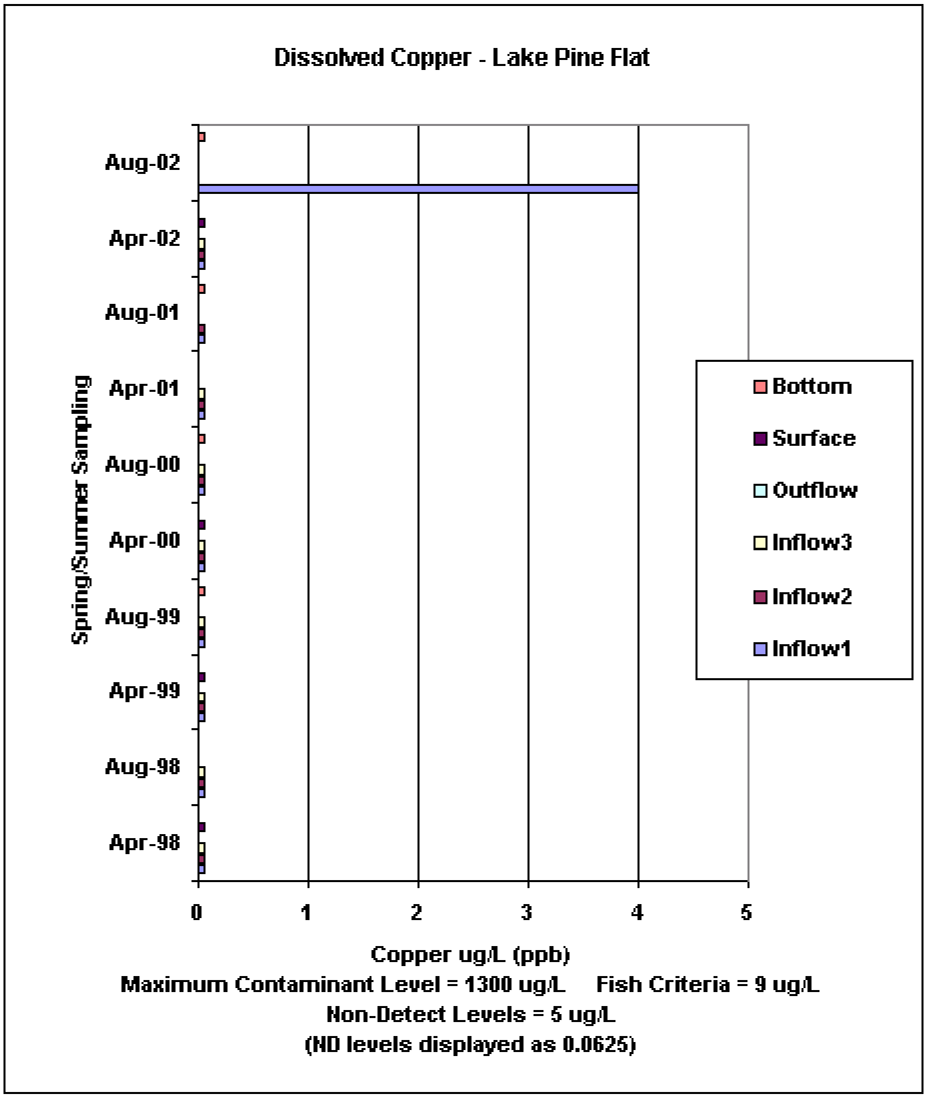


Dissolved Arsenic - Lake Pine Flat
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
5
6
Arsenic ug/L (ppb)
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Maximum Contaminant Level = 10 ug/L Fish Criteria = 150 ug/L
Non-Detect Levels = 1 ug/L before 1999, 4 ug/L after 1999
(ND levels displayed as 0.05)

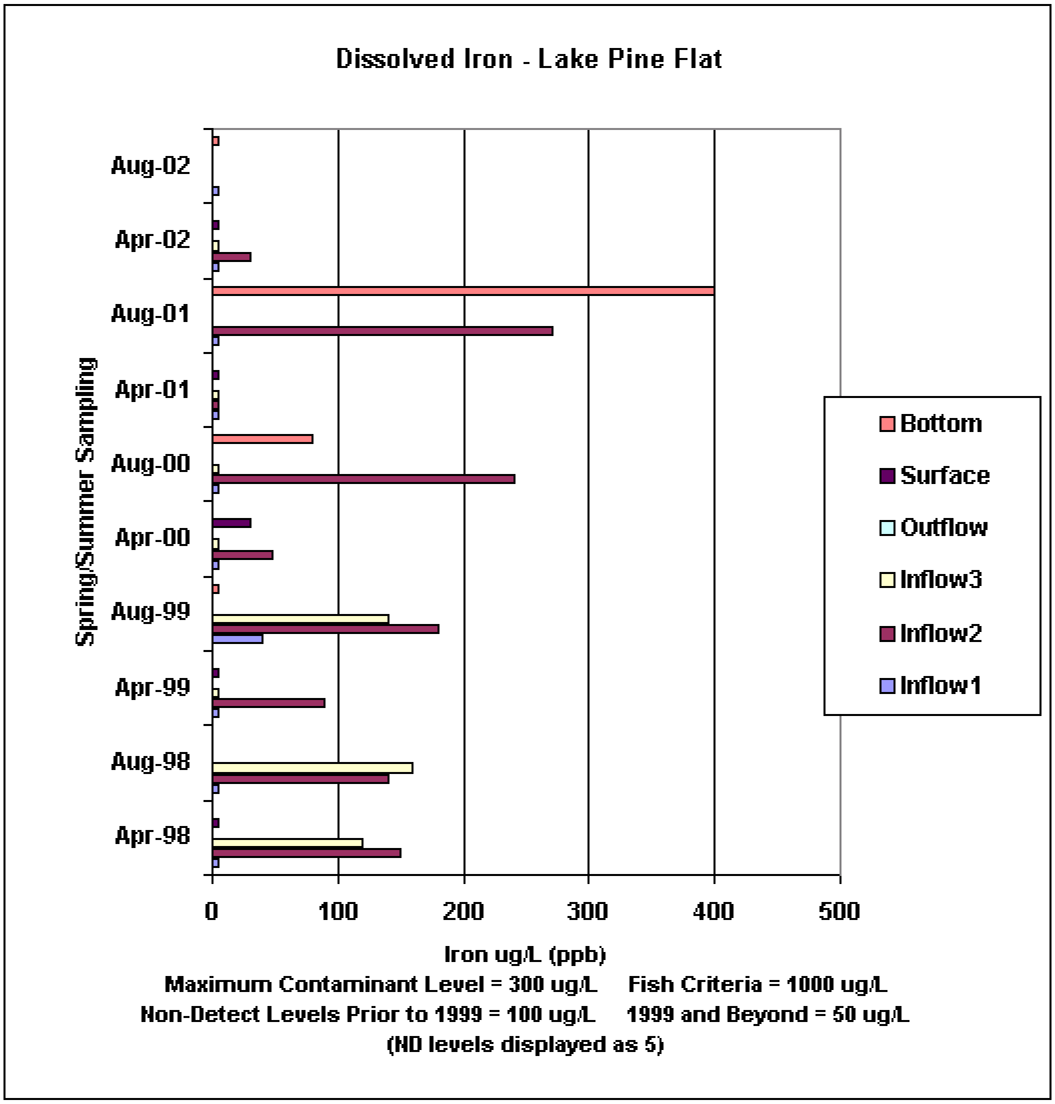


Dissolved Cadmium - Lake Pine Flat
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
0
0.1
0.2
0.3
0.4
0.5
0.6
Cadmium ug/L (ppb)
Maximum Contaminant Level = 5 ug/L Fish Criteria = 2.2 ug/L
Non-Detect Levels Prior to 1999 = 0.5 ug/L 1999 and Beyond = 1 ug/L
(ND levels displayed as 0.025)

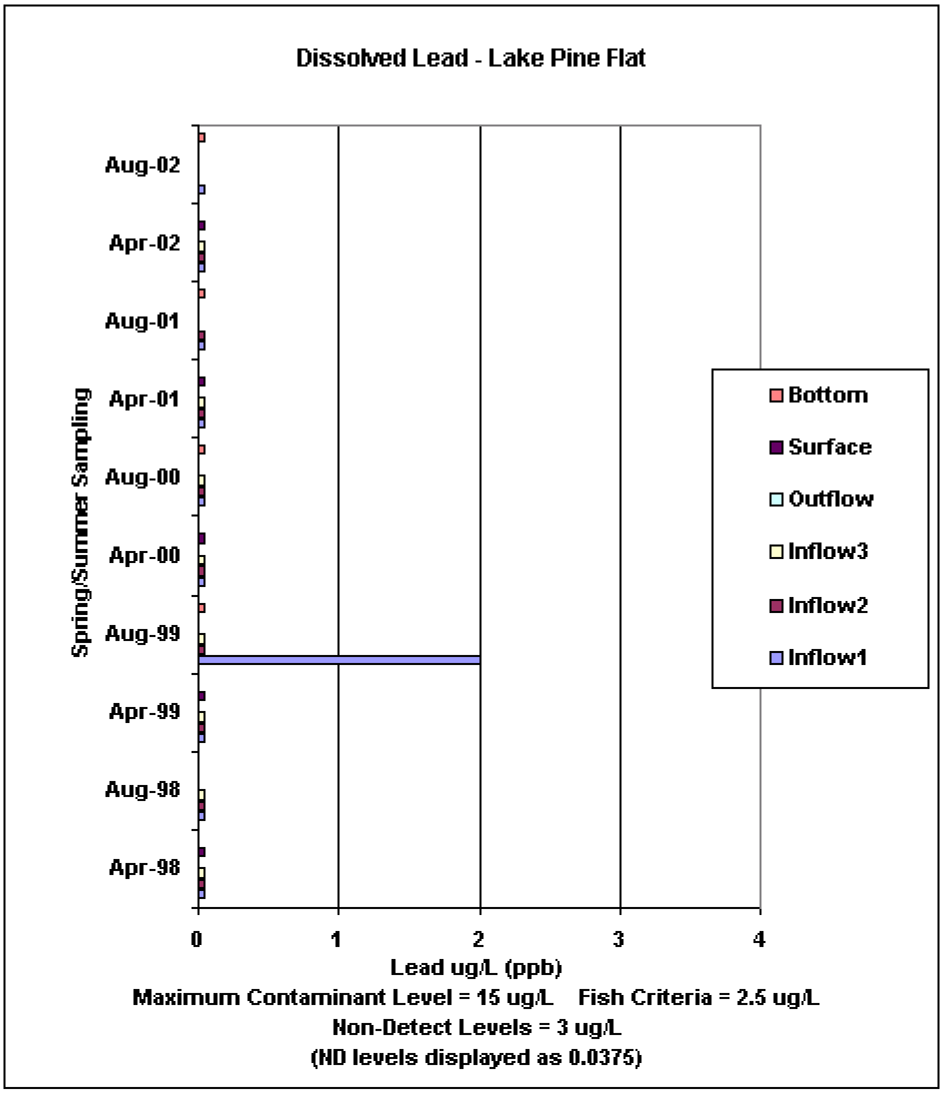

Dissolved Chromium - Lake Pine Flat
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
5
10
15
Chromium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L 1999 and Beyond = 5 ug/L
(ND levels displayed as 0.125)
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1



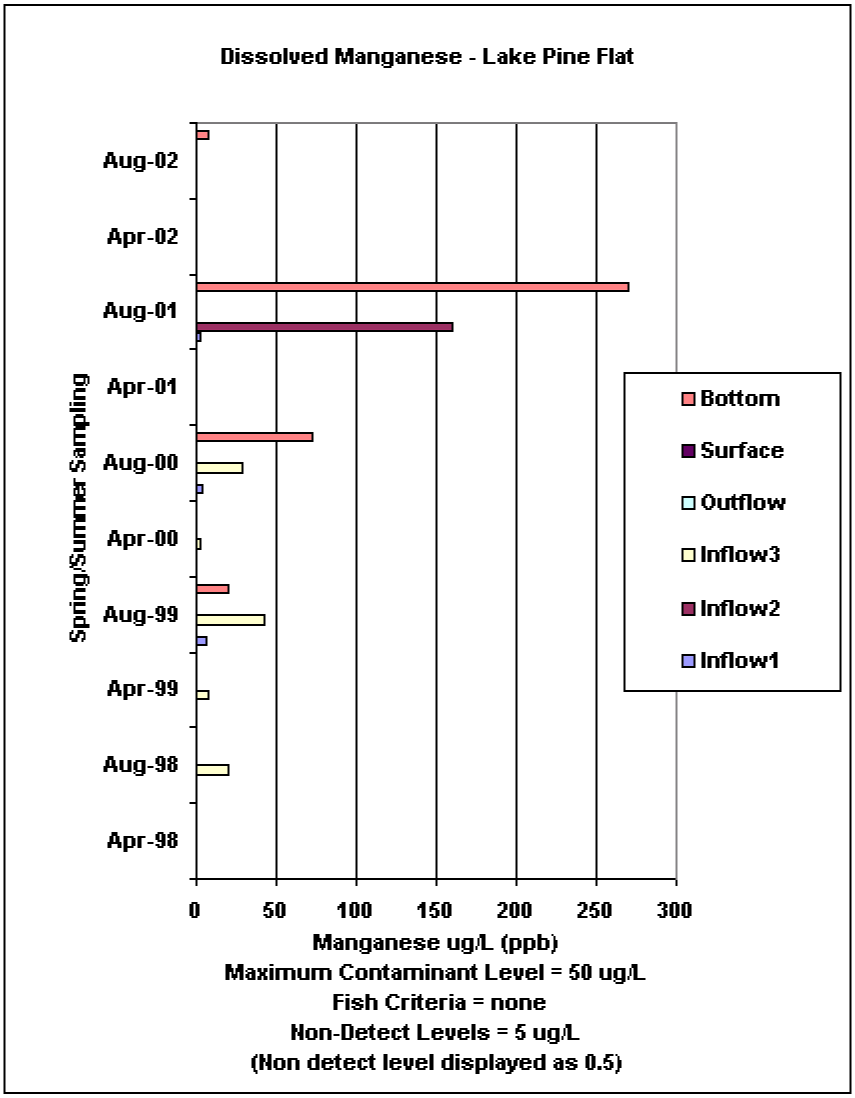
Dissolved Copper - Lake Pine Flat
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
5
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Copper ug/L (ppb)
Maximum Contaminant Level = 1300 ug/L Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L
(ND levels displayed as 0.0625)



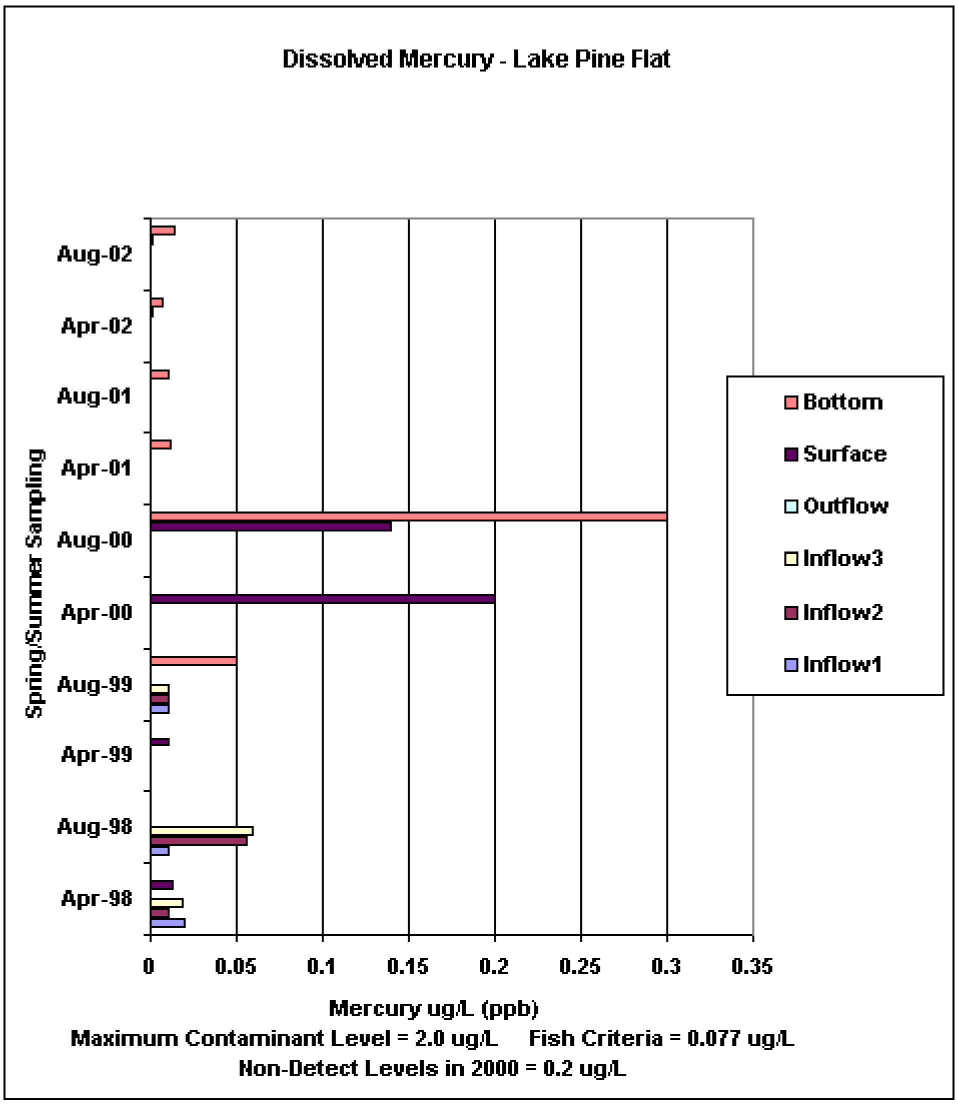
Dissolved Iron - Lake Pine Flat
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
100
200
300
400
500
Iron ug/L (ppb)
Maximum Contaminant Level = 300 ug/L   Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L   1999 and Beyond = 50 ug/L
(ND levels displayed as 5)
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1

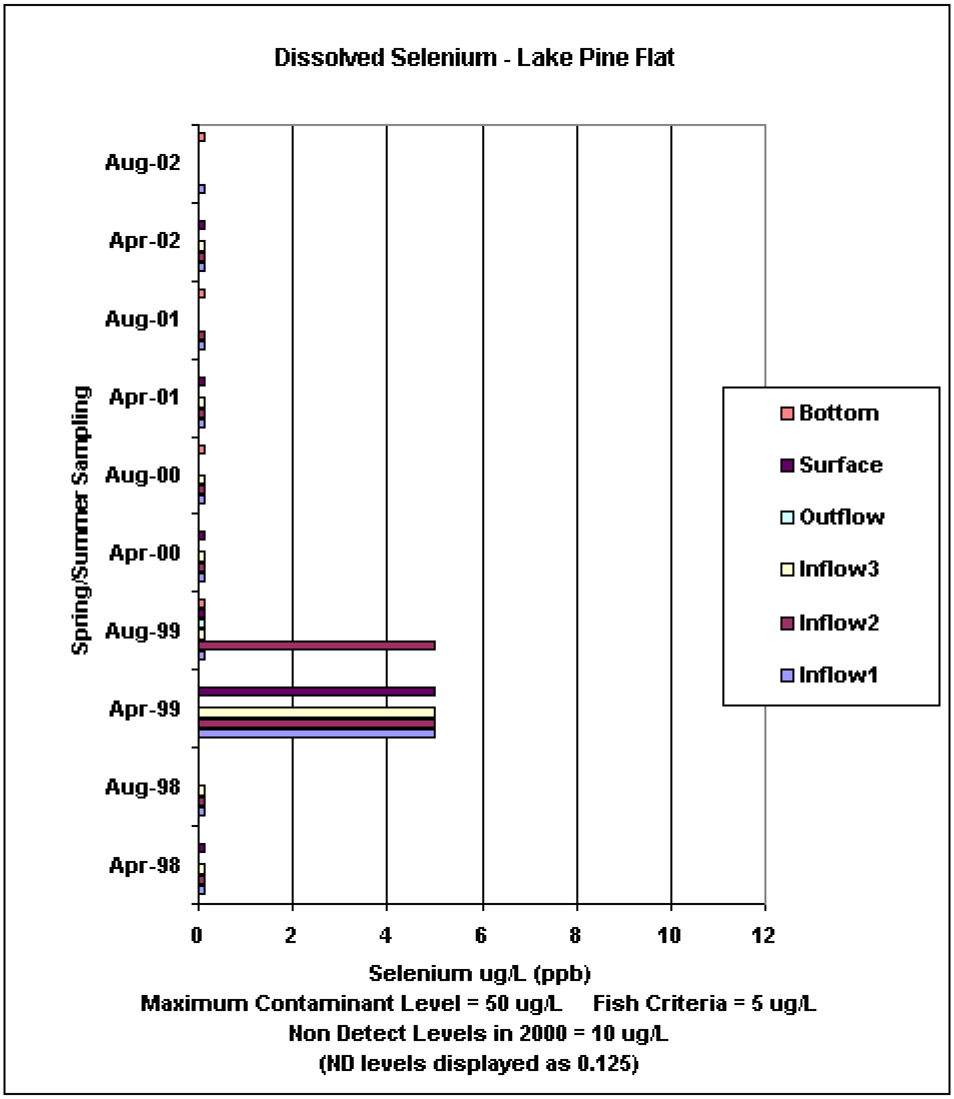


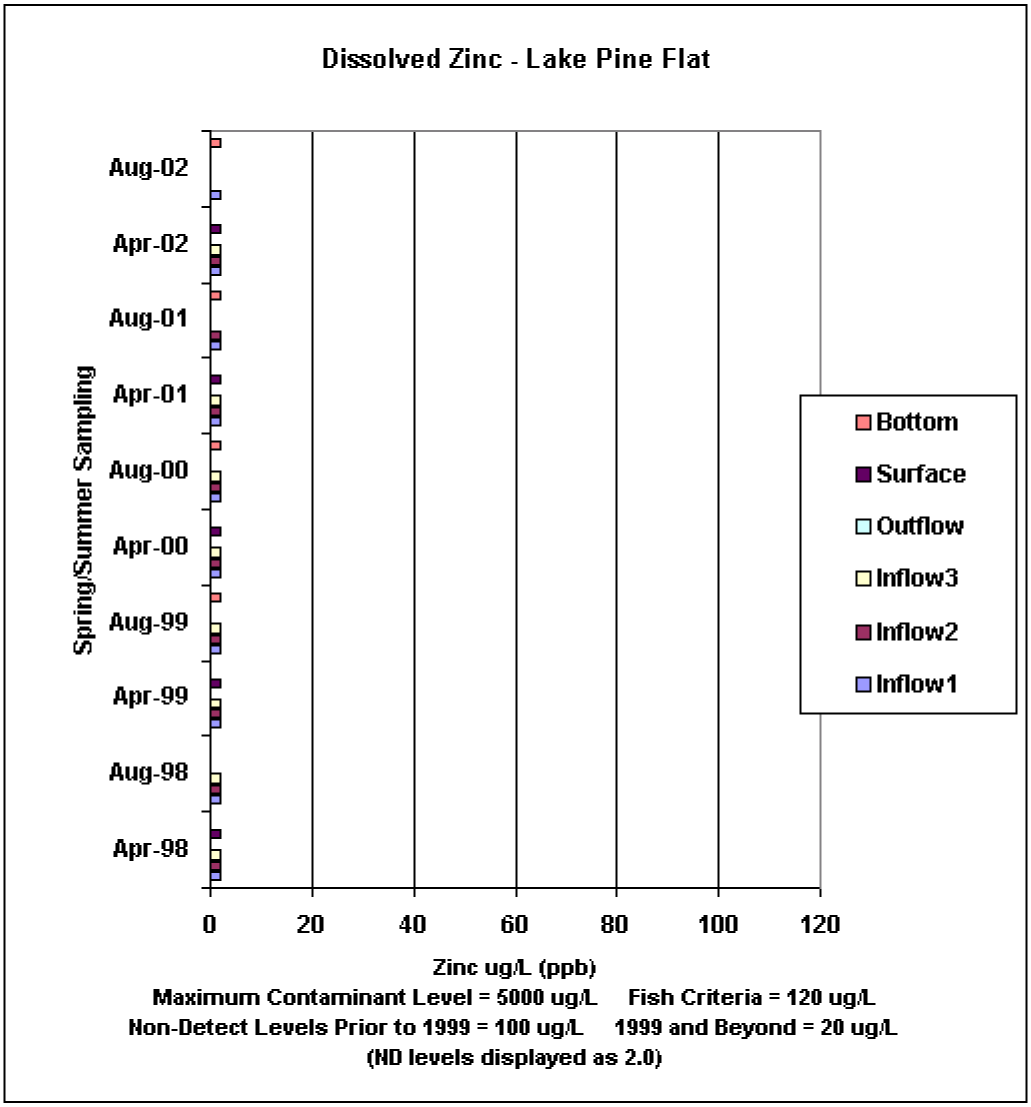
Dissolved Lead - Lake Pine Flat
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
1
2
3
4
Lead ug/L (ppb)
Maximum Contaminant Level = 15 ug/L Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L
(ND levels displayed as 0.0375)
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1



Dissolved Manganese - Lake Pine Flat
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
50
100
150
200
250
300
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Manganese ug/L (ppb)
Maximum Contaminant Level = 50 ug/L
Fish Criteria = none
Non-Detect Levels = 5 ug/L
(Non detect level displayed as 0.5)


Dissolved Mercury - Lake Pine Flat
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
Mercury ug/L (ppb)
Maximum Contaminant Level = 2.0 ug/L Fish Criteria = 0.077 ug/L
Non-Detect Levels in 2000 = 0.2 ug/L
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1


Dissolved Selenium - Lake Pine Flat
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
10
12
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Selenium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = 5 ug/L
Non Detect Levels in 2000 = 10 ug/L
(ND levels displayed as 0.125)



Dissolved Zinc - Lake Pine Flat
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
20
40
60
80
100
120
Bottom
Surface
Outflow
Inflow3
Inflow2
Inflow1
Zinc ug/L (ppb)
Maximum Contaminant Level = 5000 ug/L Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L 1999 and Beyond = 20 ug/L
(ND levels displayed as 2.0)

Appendix E: Inorganic Sample Data

Inorganic Results (mg/L) For surface lake waters (spring)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity		60	40	50	60	30	40	70	80	20		100
Ammonia		<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Chloride		21	2	21	4	4	3	<1	6	5		4
Nitrate		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1		<0.1
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Sulfate		5.3	2.6	4.2	8.9	2	1	8.2	9	2.1		4.7
Kjeldahl N		0.6	0.1	0.4	0.2	<0.1	0.3	0.2	0.2	0.2		<0.1
COD					<50							
Tot Solids		120	70	100	110	60	78	100	120	21		150

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	100	70	40	50	20	30	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	13	25	3	21	<1	<1	4	<1	6	4	3	2
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	
Sulfate	18	2.1	2.3	3	2.8	1.9	0.8	8.8	11	1.6	11	3.5
Kjeldahl N	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1
COD	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	170	130	59	110	60	60	90	110	150	30	130	90

Inorganic Results (mg/L) For surface lake waters (summer)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	140	70	40	50	50	40	70	90	80	10	80	110
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
Chloride	16	26	4	19	6	5	5	5	9	3	5	8
Nitrate	<0.1	1.5	<0.1	1.3	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1
Total P	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	16	4.1	3.6	3.5	5.9	2	0.7	7.4	14	1.6	6.4	4.4
Kjeldahl N	<0.1	2.7	<0.1	0.4	0.4	0.3	<0.1	0.2	<0.1	<0.1	0.2	0.6
COD	<50	60	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	200	190	50	120	98	80	80	120	120	52	100	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	90	40		60	40	80	100	130	20	110	180
Ammonia												
Chloride	16	490	5		10	8	3	5	14	4	5	22
Nitrate												
Total P												
Ortho P												
Sulfate	16	4.5	3		9.8	3.2	<0.5	6	14	2.7	5.4	8.7
Kjeldahl N												
COD												
Tot Solids	200	1300	50		140	100	100	150	200	50	140	280

Appendix F: MTBE Table

2002 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2002 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	2		2		<2		<2		
Eastman	5				<2				
Englebright	3		3		10		10	10	
Hensley	3		3		3		3		
Isabella	<2	<2	<2	<2	<2	<2	<2	<2	
Kaweah	2		2	<2	8		6	6	
Martis Cr.	<2				<2				
Mendocino	<2				<2				
New Hogan	<2				3				
Pine Flat	<2		<2		2		2		
Sonoma		3	<2		<2		2		
Success	4		4	4	11	12	11	11	

Notes:

1. Non-Detect is indicated by "<2" since the Reporting Limit is 2 ppb or 0.002 ppm.
2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.
3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.
4. For 2002, the number of MTBE water sampling at each lake is based on last year's lab results.
5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was historically non-detectable. The 2002 results of non-detectable levels were similar except Lake Eastman and New Hogan now reported low, detectable levels of MTBE.
6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because of historically low detectable levels of MTBE.
7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because of historically higher MTBE being found. The 2002 results were similar except Isabella now reported non-detectible levels.
8. In 2001, very high MTBE levels were reported at Lake Isabella during the Spring (18 ug/L near the marina) . During Spring 2000, Lake Isabella reported 21 ug/L. The 2002 results indicate that the previous MTBE problem near the marina was not visible during the Spring 2002 sampling event, and may have been rectified.

Appendix G: Fish Tissue Analysis Table

2002 Fish Tissue Results

The following table provides an overview of the lab results for the 2002 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conducting the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The California OEHHA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Mercury Total ppm	FDA Criteria
Black Butte	Sm M Bass	Composite (3)	6/12/02	0.24	0.26	1 ppm
Eastman	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Englebright	Note 5	N/A	N/A	N/A	N/A	
Hensley	Black Bass	Composite (3)	4/23/02	<0.10	0.72	1 ppm
Isabella	Black Bass	Composite (3)	6/4/02	0.20	0.21	1 ppm
Kaweah	Sm M Bass	Composite (3)	7/14/02	0.11	0.53	1 ppm
Martis Cr	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Mendocino	Note 6	N/A	N/A	N/A	N/A	
New Hogan	Lg M Bass	Single (1)	6/3/02	<0.10	0.34	1 ppm
Pine Flat	Note 4	--------------------	-----------	----------	-----------	< Mon 01
Sonoma	Note 6	N/A	N/A	N/A	N/A	
Success	Black Bass	Composite (3)	4/15/02	<0.10	0.18	1 ppm

Notes:

9. Non-Detect is indicated by "<0.02". The lab Detection Limit for mercury is 0.02 ppm.
10. Total Mercury was reported in mg/g or ppm.
11. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.
12. The fish tissue program was terminated at Eastman and Martis Creek in 2001 and in Pine Flat in 2002 due to low total mercury results. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout). For Pine Flat total mercury was 0.21 ppm in 2000 (composite of three Sacramento Sucker fish) and 0.23 in 2001 (composite of three spotted bass).
13. Due to seasonal conditions, a fish could not be successfully collected at Lake Englebright. Another attempt will be accomplished for the 2003 report.
14. Fish were not collected at Mendocino or Sonoma due to communication difficulties.

The above 2002 total mercury results indicate only Hensley is higher than average. However, in 2001, the total mercury results were only 0.30 ppm for Hensley (small mouth bass). The 2003 fish tissue program should provide additional data. EPA fact sheet on fish advisories (EPA-823-F-99-016) indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.

Annual Water Quality Report

LAKE SONOMA

Water Year 2002

Written by
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Water Quality Engineer
U. S. Army Corps of Engineers
Sacramento District
January 2003

TABLE OF CONTENTS

Lake Sonoma

I. Purpose

This report is part of an environmental monitoring program that restarted at Lake Sonoma in April 1985. The monitoring program was implemented to both ensure a continuous level of water quality in the lake for recreation and environmental health and to satisfy the Department of Army Engineering Regulation 1110-2-8154, “Water Quality and Environmental Management for Corps Civil Works Projects”.

II. Brief Description of Lake Sonoma

Lake Sonoma is located in the northern coast range of California, eleven miles northwest of Healdsburg, California. The lake was created by the completion of Warm Springs Dam in 1983. At capacity, the lake has 2,700 surface acres and is held in place by a dam that is 319 feet high and 3,000 feet long. The structure provides flood damage reduction and water conservation. Since being built for flood control and irrigation, the lake has also become a popular destination for recreation.

Water quality monitoring by the United States Army Corps of Engineers (USACE) began at Lake Sonoma in April 1985. Generally there are two sample events a year, spring (April) and late summer (August). Since the start of the monitoring program, a water quality report is produced yearly to list results and address any concerns of the previous water year.

Generally, Lake Sonoma has a depth of less than 250 feet during the sampling events, and is considered a mesotrophic lake when characterized by its clarity. A mesotrophic lake is one that has physical qualities in between an oligotrophic (clear and nutrient limited, example Lake Tahoe) and a eutrophic lake (low clarity and high in nutrients, example Clear Lake). Lake Sonoma is able to maintain the dissolved oxygen in its bottom waters near 5 mg/L during warm summer months. Lake Sonoma is cool (<20ºC) in the late summer ~ 50 feet below the water surface. Due to the cool water temperatures and the relatively high summer dissolved oxygen concentration, coldwater fish species should be able to survive in Lake Sonoma . Although clearer than eutrophic (nutrient rich) lakes, mesotrophic lakes can have low water clarity due to algal blooms and sediments suspended by wind action. Water clarity is often measured in terms of Secchi Disc depth or SD (Appendix A). Historically, the water clarity in Lake Sonoma is very good with only ~2 % of the samples not meeting the recreational goal of 4 feet or greater (Figure 1). In 2001 the Spring SD measure was 15.58 feet and the late summer sample event had a SD of 10.67 feet.

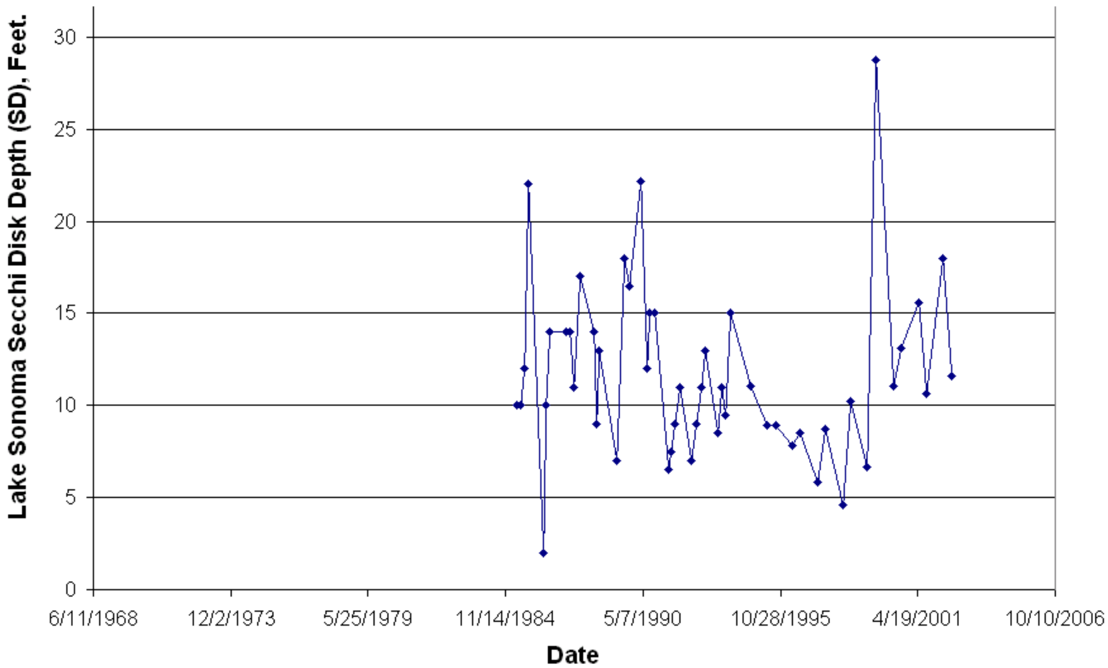

Figure 1. Historical Secchi Depth Values at Lake Sonoma (2002 values included).

The 2001 Water Quality Report listed only mercury in fish tissue as a contaminant of concern at Lake Sonoma. In 2001, the composite fish tissue sample resulted in a concentration of 0.43 ppm, which was below the U.S. FDA fish advisory of 1 ppm, but above the California Office of Environmental Health Hazard Assessment (OEHHA) action level concentration (0.3 ppm Hg) to continue monitoring.

III. Sample Summaries for this year.

Introduction

The following general summaries are split into their respective sample types. Each type of sample summary includes a discussion of both the spring (April) and late summer (August) samples to better examine trends within the current year. The types of parameters monitored this year include: Secchi Disc depths, water column profiles (temperature, DO and pH), phytoplankton characterization, metals concentrations, MTBE concentrations, and Inorganic characterization (alkalinity, phosphorous, nitrogen, etc..). Fish mercury sampling was not performed in 2002 due to coordination difficulties. For a more detailed explanation of the importance of each type of sample, please see Appendix A.

SECCHI DEPTH

The Secchi Disc depth found during the spring sampling events was higher than the historical average(historical mean SD = 8.3 feet), while the late summer Secchi depth was lower than the average. More often the clarity is better in the late summer than in the late spring, but it wasn't true of this year. At the spring sampling event the water clarity was high (Spring 2002 SD = 18.0 feet), which was better than the previous year (2001 Spring SD = 15.58 feet). The late summer SD of 11.58 feet was above the recreational goal of 4 feet and slightly higher than the previous year (Summer 2001 SD = 10.67) (Appendix B).

TEMPERATURE VALUES

The temperature profiles for Lake Sonoma are indicative of a well stratified lake. The lake appears to remain stratified through the warm temperatures of late summer. The lake water depth difference between the spring and late summer sampling events (spring depth = 216.5 feet, late summer depth = 223.1 feet) was minimal. While the surface temperatures were very different (spring surface temp. = 16.83 ºC, late summer surface temp.= 22.71 ºC), the average temperature for the lake was not much different (spring average temp. = 11.41 ºC, late summer average temp.= 13.4 ºC). Lake Sonoma is able to regulate its temperature due to having a cooler deep-water area throughout the year to buffer it from the warm summer air temperatures. It is likely that Lake Sonoma would be able to support coldwater fish species. For detailed results obtained during the sampling events, please see Appendix B.

DISSOLVED OXYGEN

The dissolved oxygen (DO) concentration in the lake differs greatly from spring to late summer. In the spring DO concentrations are 11.56 mg/L near the surface and 8.16 mg/L at the bottom of the lake. DO concentrations near the surface are reflect super saturation (DO saturation is 9.69 mg/L at 16.83 º C). Super saturation is caused by oxygen production during phytoplankton photosynthesis. DO concentrations in the late summer were highest near the surface (DO = 6.15mg/l) and was lowest near the middle of the lake (DO = 4.53 mg/L). Fish species that require greater than 5 mg/l DO at cooler water temperatures (< 20ºC) should be able to survive year round in Lake Sonoma. For detailed results obtained during the sampling events, please see Appendix B.

PH Values

In the spring sampling event pH values in the lake were slightly basic throughout the water column. In the spring the highest pH was near the surface (Spring 2002 surface pH = 7.8) and the lowest was at the bottom (Spring 2002 bottom pH = 7.35). The pH values in the late summer profile varied widely and on average less basic and a region of slightly acidic pH was located at the bottom. The pH was most basic towards the middle waters (Late Summer 2002 max pH = 7.73) and slightly acidic bottom (Late Summer 2002 pH bottom = 6.83). For detailed results obtained during the sampling events, please see Appendix B.

PHYTOPLANKTON

In the spring sample, the algal biomass within the lake was higher than spring 2001 biomass values(2002 spring biomass = 155.75 ug/L ; 2001 spring biomass = 41.60 ug/L). In spring 2002 diatoms were the most dominant species, while in spring 2001 green algae was most plentiful. In late summer an opposite trend occurred. The phytoplankton population was lower in summer 2002 (2002 Summer Biomass = 173.44 ug/L) than summer 2001 (2001 Summer Biomass = 203.17 ug/L). In late summer 2002, diatoms had the largest population. Dinoflagellates were the most dominant species in the summer 2001 sample. For detailed results obtained during the 2002 sampling events, please see Appendix C.

METALS

None of the dissolved heavy metal samples exceeded the maximum contaminant level (MCL) or the freshwater fishery criteria during the 2002 spring and summer sampling events. Contaminants will continue to be monitored in the coming year for any changes. For detailed results obtained during the sampling events, please see Appendix D.

MTBE

The highest concentration of MTBE in both spring and late summer sampling events (MTBE high =3 ppb) was just above the detection limit of 2 ppb. Due to being found at such low concentrations, MTBE was not a contaminant of concern in 2002. For detailed results obtained during the sampling events, please see Appendix F.

INORGANIC ANALYSIS

The spring and summer sample results were within expected ranges and levels. For detailed results obtained during the 2002 sampling events, please see Appendix E.

IV. Conclusions

Lake Sonoma is a mesotrophic lake that can support both warmwater and coldwater fish species. Both temperatures and dissolved oxygen concentrations are maintained at levels adequate for the various fish species to thrive.

In the 2002, Lake Sonoma sampling results indicated that there were no contaminants of concern. An area that requires improvement is the coordination of fish sampling so that data will be available for the 2003 water quality report. This is especially important since it was listed as a contaminant of concern in the 2001 Water Quality Report.

V. References

North American Lake Management Society (1990). *Lake and Reservoir Restoration Guidance Manual*, EPA 440/4-90-006, U.S. Environmental Protection Agency, Washington, DC.

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VI. Appendices

Appendix A: Glossary of Sample Types

Glossary of Sample Types

This glossary of sample types is intended to provide a general background and indicate the importance of each sample in determining water quality. These are meant to be brief and basic. If a further explanation is desired please refer to the list of references provided in this report.

Secchi Depth

One of the oldest and easiest methods to determine lake clarity is the Secchi depth (SD). The Secchi depth is determined by dropping a Secchi disc into a water body and determining the depth that it is last visible from the surface of the water. Secchi discs are generally white and 20 cm in diameter. Secchi depth values are most impacted by the light intensity at the time of sampling and the scattering of light by solid particulates within the water column. Algal growth (phytoplankton) and sediment re-suspension are often major constituents of solid particulates within the water column. Secchi depth values can be used to estimate the Trophic state or the nutrient levels within the lake. The more nutrients are available, the larger likelihood of algal blooms that limit water clarity. Due to recreational concerns for safety, the goal for Secchi depth values is four feet or greater.

Temperature Profiles and Data Points

The temperature profile of a lake provides information how a lake is operating and the potential for aquatic biota to live within the lake. The temperature profile is a direct indicator if a lake is stratified. Stratification in lakes is created generally by temperature affecting the density of water molecules. Stratification is usually indicated by a region of similar temperature nearer the surface of the water (epilimnion), then a region of temperature transition (metalimnion), to another layer of nearly constant temperature at the bottom of the lake (hypolimnion). Each layer in a stratified lake is important, but the existence of a hypolimnion can drastically impact how well a lake can handle warmer temperatures such as those found in northern California during the summer. The hypolimnion acts as a buffer against large temperature shifts. The nature of dam operation is that water is discharged near the bottom, releasing the hypolimnion, and eliminating stratification. This operation limits the ability of reservoirs to regulate their temperature during the summer months. Stratification isn't always desirable. When a lake isn't stratified and is instead well mixed, the required nutrients near the bottom of the lake become available to phytoplankton for growth. Temperatures within lakes also indicate which species of fish will survive within a lake. Coldwater species of fish require temperatures below 20 degrees C in order to spawn and survive. If a lake is often above 20 degrees C, then only warmwater fish species will survive.

Dissolved Oxygen (DO) Concentration Profiles

DO is required by organisms for respiration and for chemical reactions within lake waters. The recommended level for DO for most aquatic species survival is 5mg/L. In lakes, biota waste (detritus) falls to the bottom of the lake to be utilized by bacteria. The bacteria need oxygen and will deplete levels near the bottom of a lake, especially during

warm temperature, high respiration conditions. For nutrient rich (eutrophic) lakes more organisms will grow, create wastes, and cause oxygen depleted regions at the lowest areas. Under these conditions only aquatic species that can survive low DO conditions in warm water near the surface will survive.

PH Profiles

The pH profiles of the lakes indicate the potential for certain chemical reactions to occur. In high pH (greater than pH = 7 or basic) aquatic systems, metal pollutants tend to form into insoluble compounds that fall onto the lake floor. In low pH (less than pH = 7 or acidic) systems or areas metal ions become soluble and available for uptake into aquatic organisms. Other compounds like ammonia that are introduced into a low pH aquatic environment will transform into soluble nitrate and be utilized by organisms.

Phytoplankton Analysis

Phytoplankton analysis indicates the health, nutrients, and biodiversity within a lake. Lakes that have few nutrients available (Oligotrophic) will generally have a much lower quantity of phytoplankton (high Secchi depth) but the number of phytoplankton species seen will be large. In a lake that is nutrient rich (eutrophic) there are generally large phytoplankton blooms (low Secchi depth), but they are made up of a couple of phytoplankton species. Certain species of phytoplankton are preferred food sources for zooplankton (small invertebrates). Generally species like diatoms and green algae can be consumed by the filter-feeding zooplankton, but species like bluegreen algae are low in nutrients and are difficult to consume. Some species like the dinoflagellates can grow horn like points to discourage potential predators. In nutrient rich waters where there is plenty of phosphorous, nitrogen can be limited for biological growth. While most species can't grow due to the lack of nitrogen, bluegreen algae (cyanobacteria) have the ability to utilize nitrogen from the atmosphere when required. This gives bluegreen algae the ability to dominate in many eutrophic lakes.

Soluble Metals Analysis

The soluble metals analysis indicates the exposure of humans and aquatic organisms to toxic metals. These metals often build up as they are consumed through the food chain. Water samples provide an indicator for additional problems. Soluble forms of metal ions are more prevalent in low pH (pH <7, or acidic) environments.

MTBE Analysis

MTBE (methyl tertiary-butyl ether) is a chemical additive to gasoline to improve combustion. Due to its high solubility, MTBE travels and blends into aquatic systems rapidly. While not found to be extremely hazardous at low levels, the offensive smell and taste is detectible by humans at extremely low concentrations. The effect of MTBE on humans and aquatic systems is still under investigation.

Inorganic Analysis

Alkalinity

Alkalinity is measured in terms of mg/L of calcium carbonate. It indicates a lakes ability to buffer incoming acidic pollution and situational changes.

Ammonia

Ammonia is a gas that is toxic to fish and is more visible at a higher pH. Ammonia is created through anthropogenic inputs, bacteria cell respiration, and the decomposition of dead cells. Due to being a gas, given time ammonia will volatilize from the water. At a lower pH, much of the ammonia is converted to ammonium (a nutrient for root bound plant life) and utilizes DO in the nitrification process.

Chloride

The chloride ion is an indicator of any salinity increases within a lake. Most fresh water aquatic species are sensitive to salinity changes.

Nitrate

Nitrate is the nitrogen product created through the nitrification of ammonium. Nitrate is a soluble form of the nutrient nitrogen and is utilized by phytoplankton.

Total Phosphorous

The total phosphorous provides a measure of both utilized and soluble phosphorous within water samples. Phosphorous is a required nutrient for plant growth and development.

Ortho Phosphorous

Ortho phosphorous is the soluble form of phosphorous that is utilized by free-floating aquatic plants (phytoplankton).

Kjeldahl N

Kjeldahl nitrogen or total Kjeldahl nitrogen (TKN) is a measure of the total concentration of nitrogen in a sample. This includes ammonia, ammonium, nitrite, nitrate, nitrogen gas, and nitrogen contained within organisms.

COD

Chemical Oxygen Demand (COD) is a measure of the total oxygen required to complete the chemical and biological demands of a sample.

Fish Tissue Analysis

Fish tissue is analyzed to examine potential exposure of humans to toxicants as well as the health of the aquatic food chain. In aquatic systems toxic contaminants can build up (or bioaccumulate) within animals at the top of the food chain. Contaminants (especially organic pollutants) are retained within the fat tissue of an organism, therefore in fish samples the lipid content is often measured.

Lake Code Designation

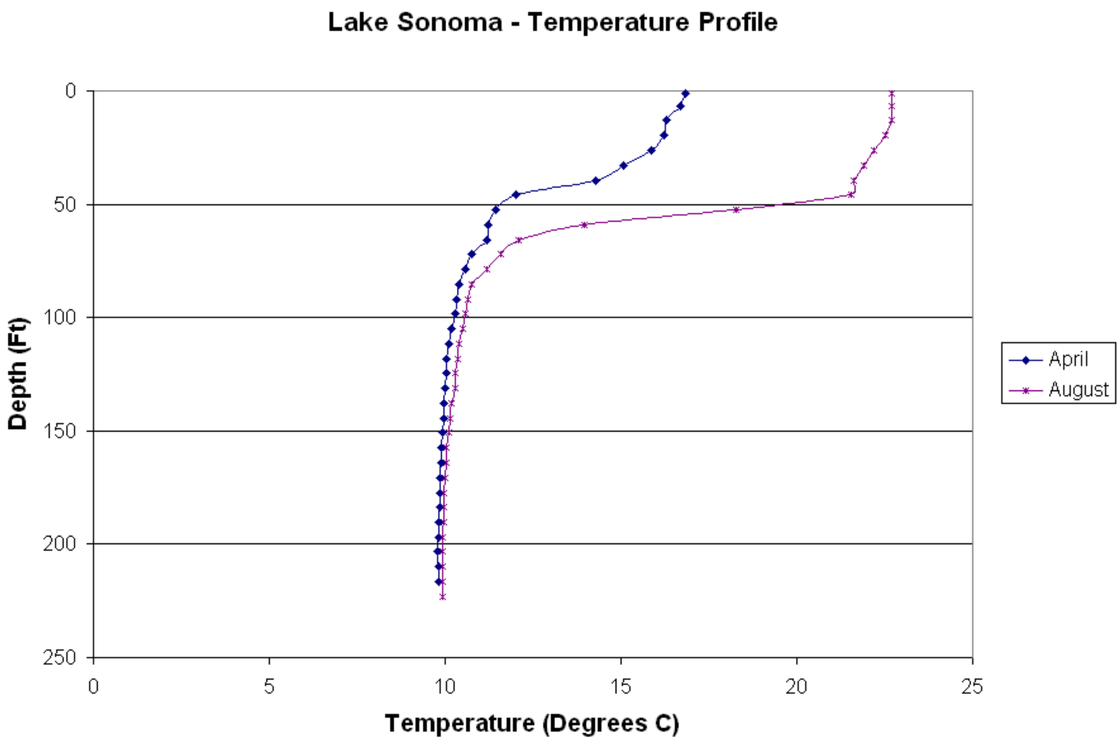
Laboratory Reports are provided in the previous sections.

Sample ID is "XX-YY-ZZ" where

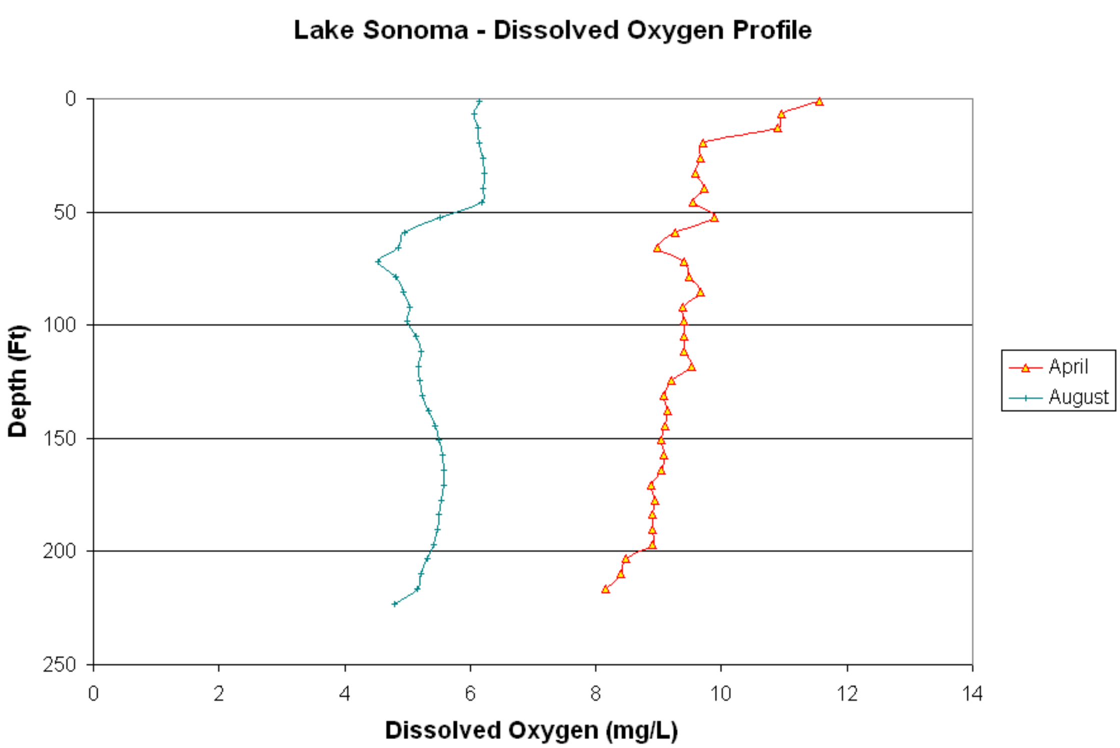
XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summar	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

Example: BB-SU-S is for a water sample taken from Black Butte in the Summer on the Lake's Surface.

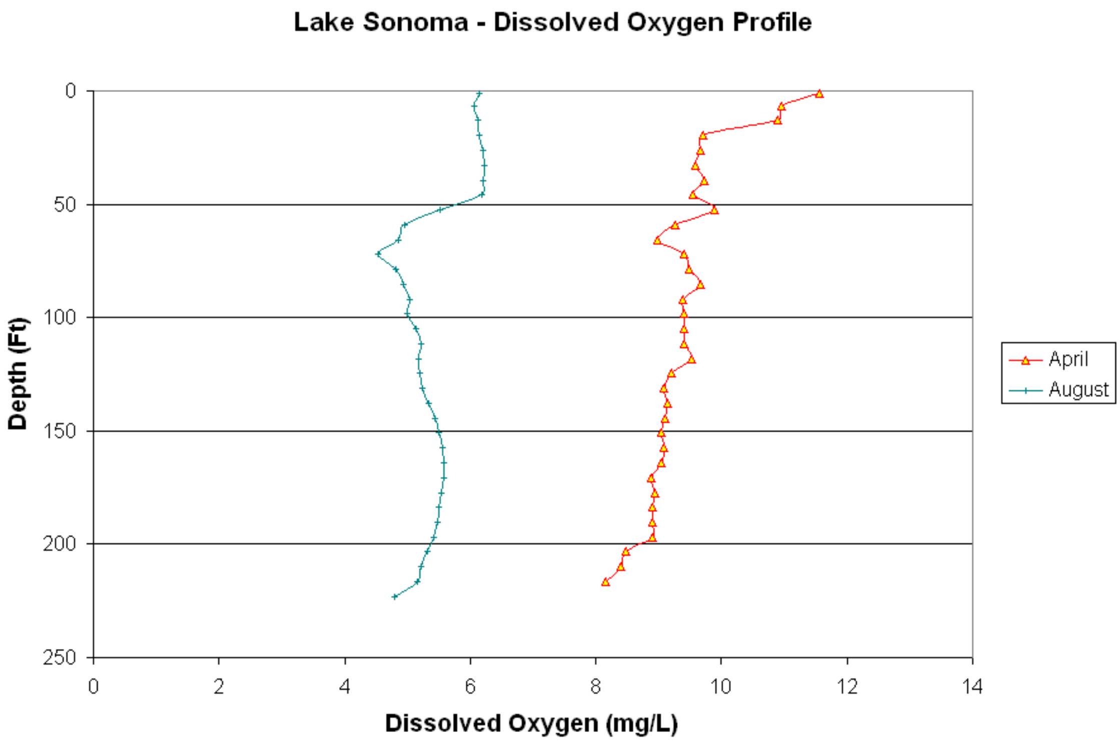
Appendix B: Profile Data and Charts (Secchi Disc, Temperature, DO, and pH)



Lake Sonoma - Temperature Profile
Depth (Ft)
Temperature (Degrees C)
0
50
100
150
200
250
0
5
10
15
20
25
April
August



Lake Sonoma - Dissolved Oxygen Profile
Depth (Ft)
Dissolved Oxygen (mg/L)
0
50
100
150
200
250
0
2
4
6
8
10
12
14
April
August

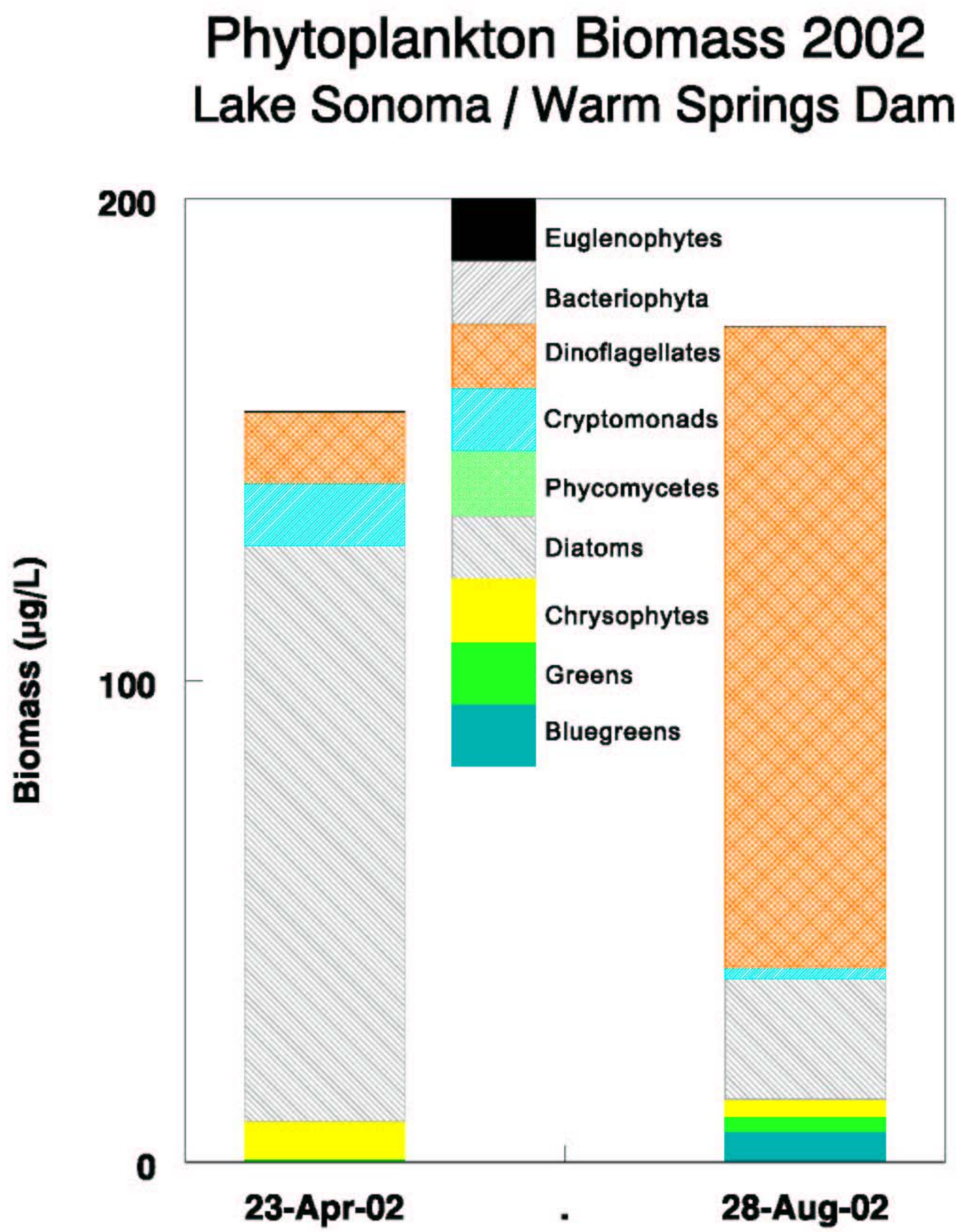


Lake Sonoma - Dissolved Oxygen Profile
Depth (Ft)
0
50
100
150
200
250
0
2
4
6
8
10
12
14
Dissolved Oxygen (mg/L)
April
August

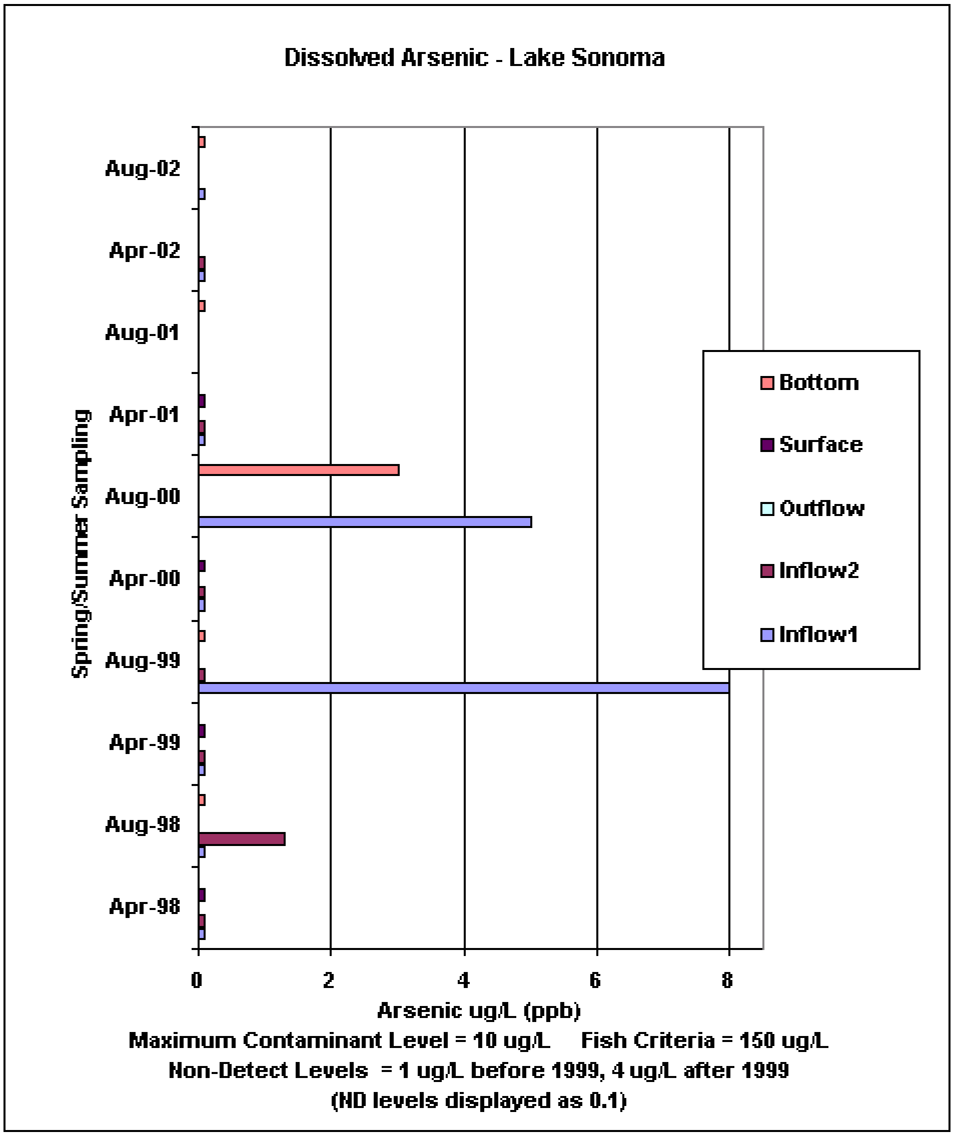
SONOMA					
Sample Location: Behind dam				**Date:** 4/23/02	
Observers: Tim McLaughlin				**Time:** 9:45 am	
Lake Elevation: 450.46					
Weather Conditions:					
Wind Speed (mph): 5		**Precipitation:** 0		**Temp (F):** 65	
SECCHI Depth: 18 feet					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
65	216.5	9.81	107	8.16	7.35
64	210.0	9.81	108	8.41	7.40
62	203.4	9.80	108	8.48	7.42
60	196.9	9.82	108	8.91	7.46
58	190.3	9.83	109	8.91	7.47
56	183.7	9.84	109	8.91	7.48
54	177.2	9.84	108	8.94	7.50
52	170.6	9.86	108	8.88	7.50
50	164.1	9.89	107	9.04	7.51
48	157.5	9.91	109	9.09	7.53
46	150.9	9.93	110	9.05	7.55
44	144.4	9.96	109	9.10	7.56
42	137.6	9.97	109	9.14	7.58
40	131.2	10.00	110	9.09	7.61
38	124.7	10.02	109	9.20	7.60
36	118.1	10.05	111	9.52	7.58
34	111.5	10.11	112	9.40	7.60
32	105.0	10.19	112	9.41	7.60
30	98.4	10.29	111	9.40	7.61
28	91.9	10.32	112	9.39	7.64
26	85.3	10.41	112	9.67	7.65
24	78.7	10.56	113	9.48	7.67
22	72.2	10.76	112	9.40	7.69
20	65.6	11.19	113	8.99	7.70
18	59.1	11.21	112	9.27	7.71
16	52.5	11.43	112	9.90	7.71
14	45.9	12.02	115	9.55	7.72
12	39.4	14.29	115	9.73	7.76
10	32.8	15.07	115	9.59	7.75
8	26.2	15.88	116	9.66	7.75
6	19.7	16.22	115	9.70	7.75
4	13.1	16.29	115	10.89	7.77
2	6.6	16.69	115	10.95	7.78
0.03	1	16.83	116	11.56	7.79
DRY CREEK (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
61.6	7.43		-	-	-
WARM SPRINGS (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
63.6	7.65		-	-	-
VISUAL OBSERVATIONS:					

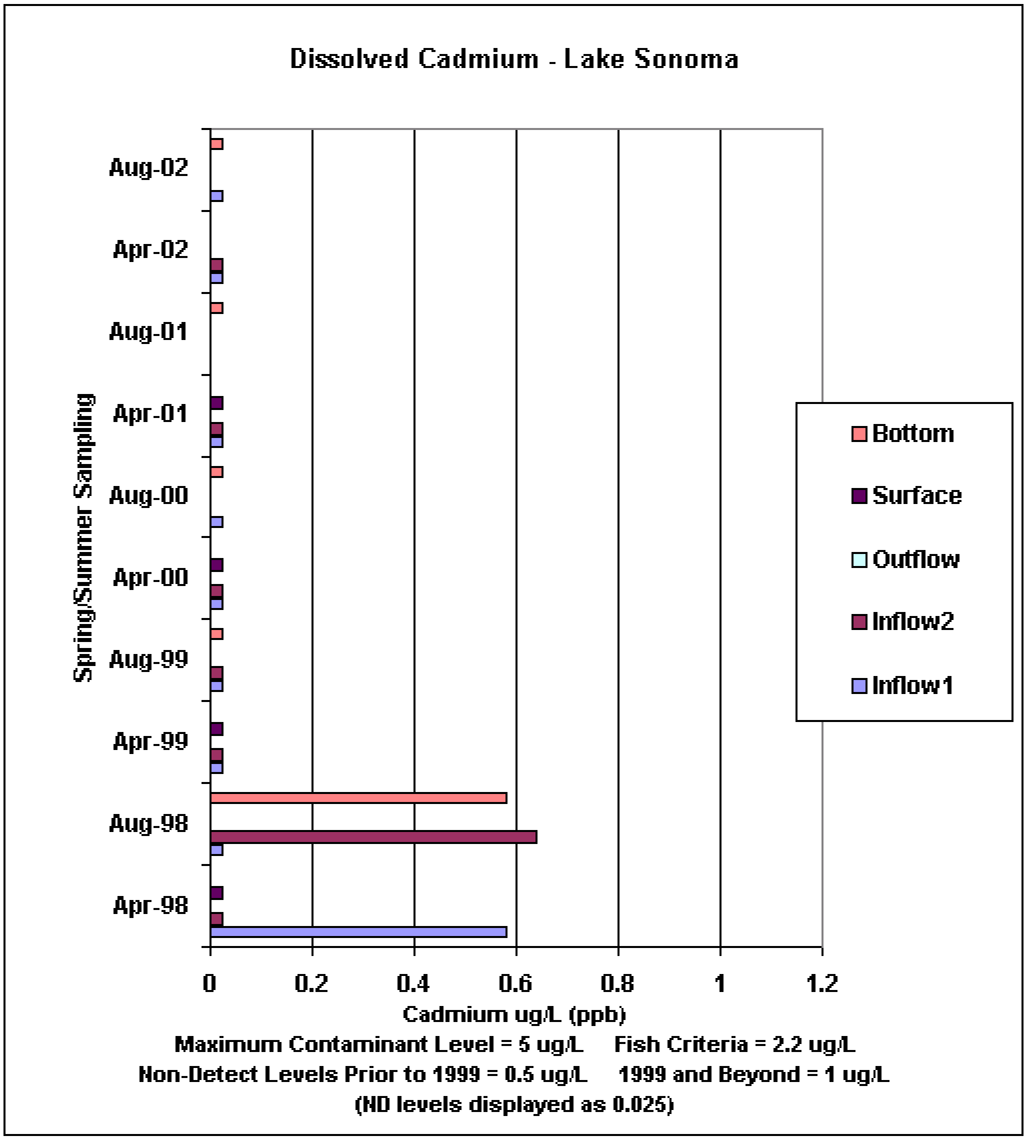
SONOMA					
Sample Location: Behind dam				**Date:** 8/28/02	
Observers: Tim McLaughlin				**Time:** 10:05 am	
Lake Elevation: 438.81					
Weather Conditions:					
Wind Speed (mph): 15		**Precipitation:** 0		**Temp (F):** 80	
SECCHI Depth: 11 feet and 7 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
67.1	223.1	9.94	146	4.8	6.83
66	216.5	9.93	146	5.16	6.86
64	210.0	9.93	145	5.21	6.87
62	203.4	9.94	145	5.31	6.89
60	196.9	9.94	145	5.41	6.89
58	190.3	9.95	145	5.48	6.92
56	183.7	9.96	145	5.5	6.91
54	177.2	9.97	144	5.53	6.93
52	170.6	9.99	144	5.57	6.94
50	164.1	10.02	144	5.58	6.95
48	157.5	10.05	145	5.56	6.96
46	150.9	10.09	145	5.50	6.95
44	144.4	10.14	146	5.43	6.96
42	137.6	10.17	146	5.34	6.98
40	131.2	10.27	147	5.24	6.97
38	124.7	10.29	147	5.20	6.97
36	118.1	10.36	148	5.17	6.98
34	111.5	10.41	148	5.22	7.00
32	105.0	10.50	147	5.13	7.09
30	98.4	10.58	148	5.00	7.13
28	91.9	10.64	148	5.03	7.16
26	85.3	10.76	148	4.94	7.20
24	78.7	11.19	148	4.81	7.20
22	72.2	11.59	147	4.53	7.25
20	65.6	12.10	150	4.86	7.30
18	59.1	13.96	152	4.96	7.35
16	52.5	18.26	155	5.51	7.45
14	45.9	21.54	165	6.18	7.72
12	39.4	21.62	166	6.20	7.71
10	32.8	21.91	165	6.22	7.73
8	26.2	22.20	165	6.21	7.64
6	19.7	22.53	166	6.15	7.52
4	13.1	22.69	165	6.12	7.39
2	6.6	22.70	165	6.07	7.28
0.03	1	22.71	165	6.15	7.05
DRY CREEK (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
71.5	7.34		-	-	-
WARM SPRINGS (Inflow) - DRY					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
-	-		-	-	-
VISUAL OBSERVATIONS:					

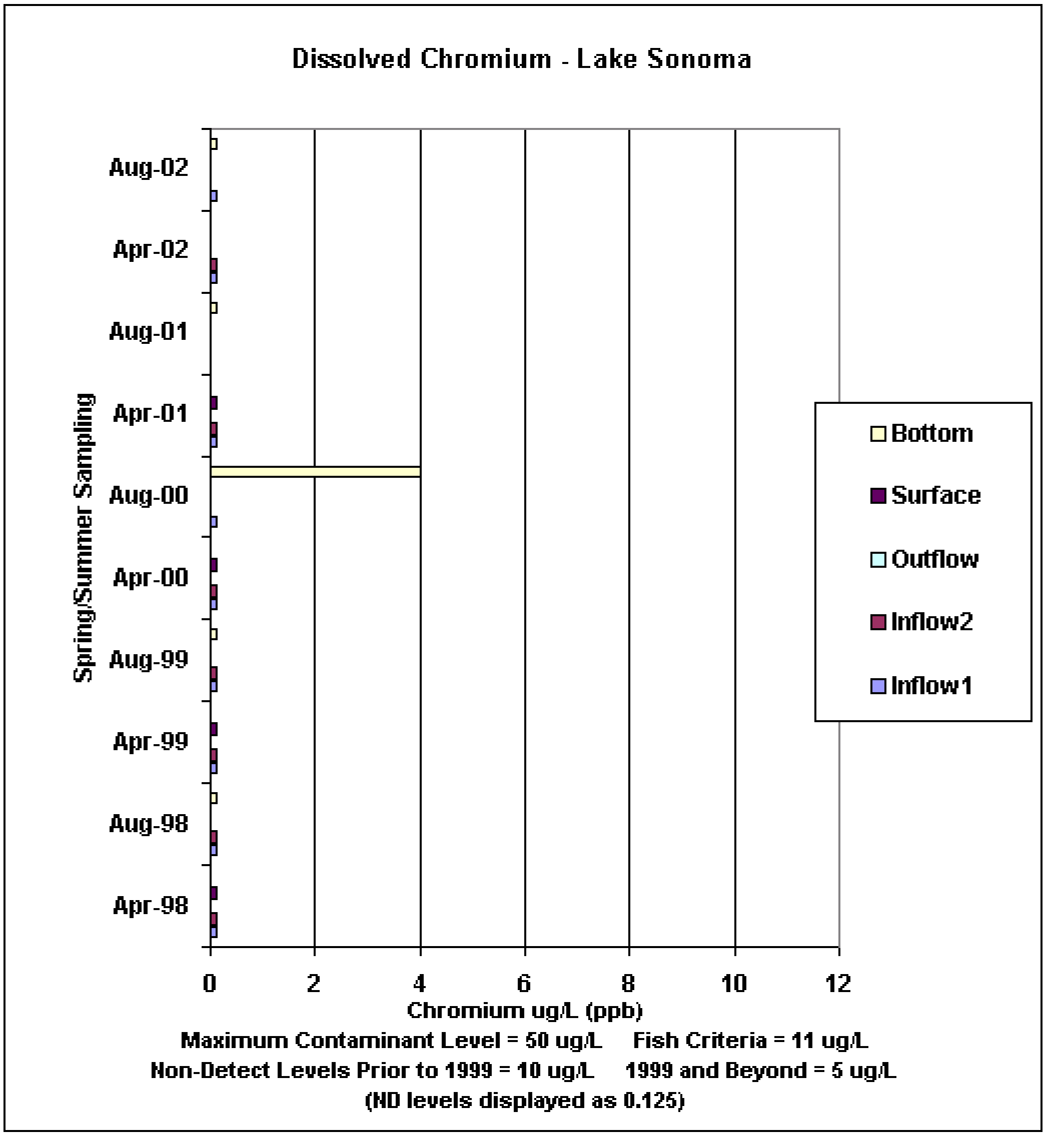
Appendix C: Phytoplankton Data and Charts


Phytoplankton Biomass 2002
Lake Sonoma / Warm Springs Dam
200
100
0
Biomass (µg/L)
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
23-Apr-02
.
28-Aug-02

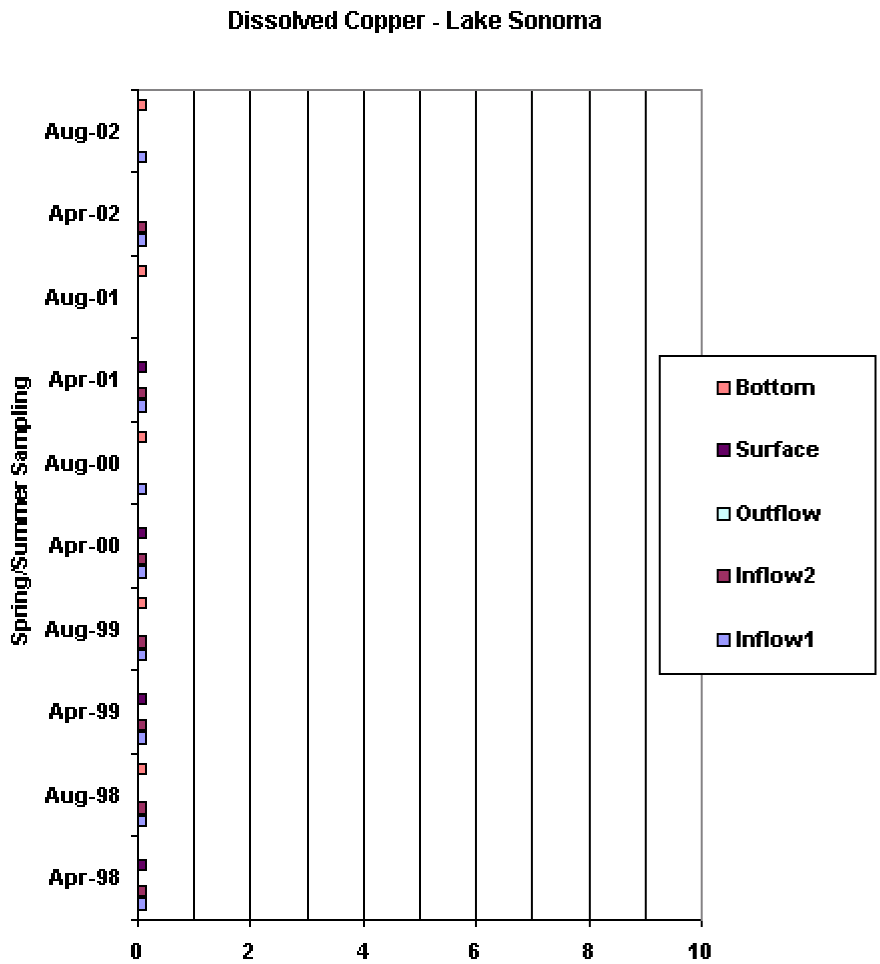
Appendix D: Metals Data and Charts


Dissolved Arsenic - Lake Sonoma
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
2
4
6
8
Bottom
Surface
Outflow
Inflow2
Inflow1
Arsenic ug/L (ppb)
Maximum Contaminant Level = 10 ug/L Fish Criteria = 150 ug/L
Non-Detect Levels = 1 ug/L before 1999, 4 ug/L after 1999
(ND levels displayed as 0.1)

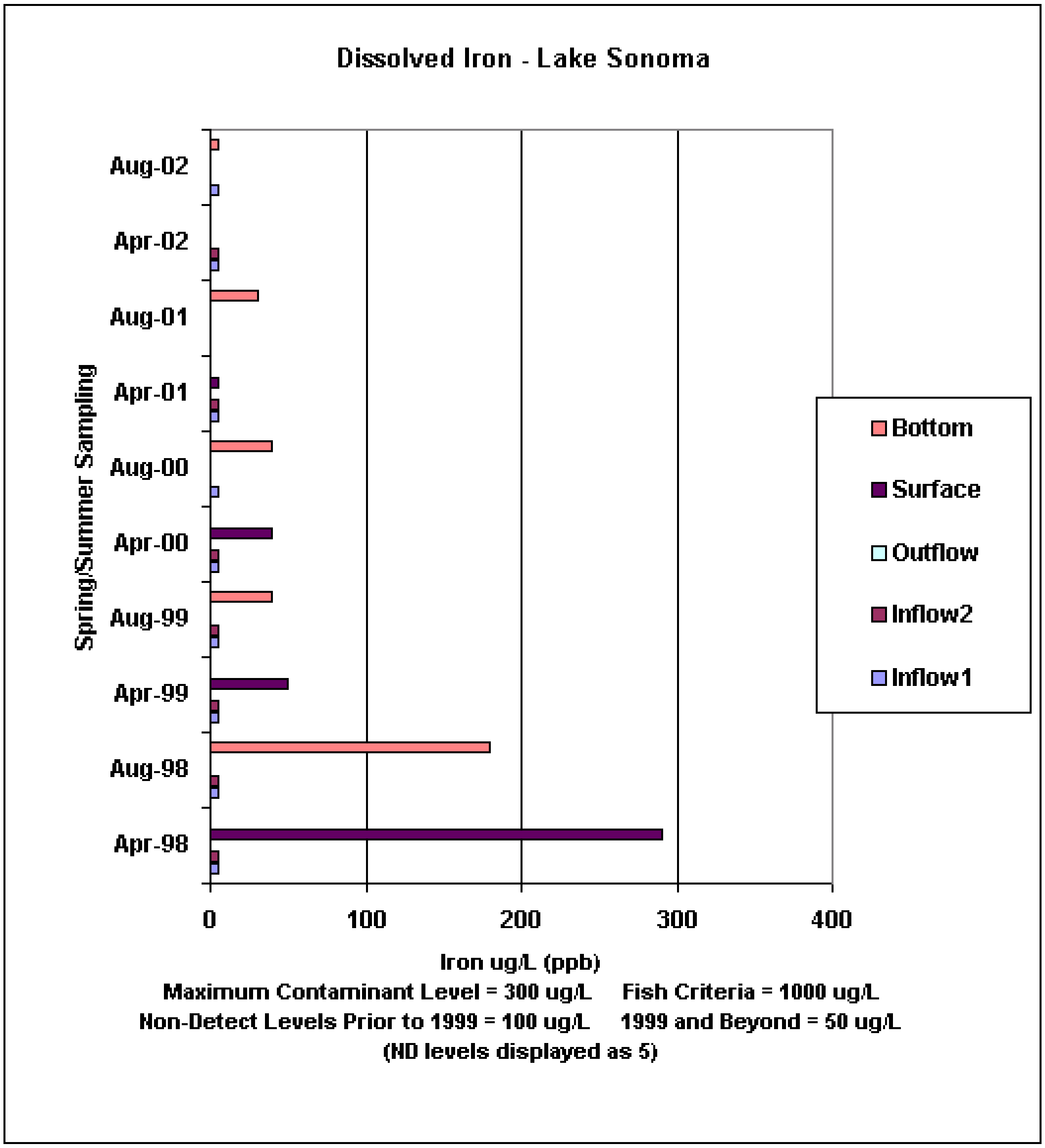

Dissolved Cadmium - Lake Sonoma
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.2
0.4
0.6
0.8
1
1.2
Cadmium ug/L (ppb)
Bottom
Surface
Outflow
Inflow2
Inflow1
Maximum Contaminant Level = 5 ug/L Fish Criteria = 2.2 ug/L
Non-Detect Levels Prior to 1999 = 0.5 ug/L 1999 and Beyond = 1 ug/L
(ND levels displayed as 0.025)



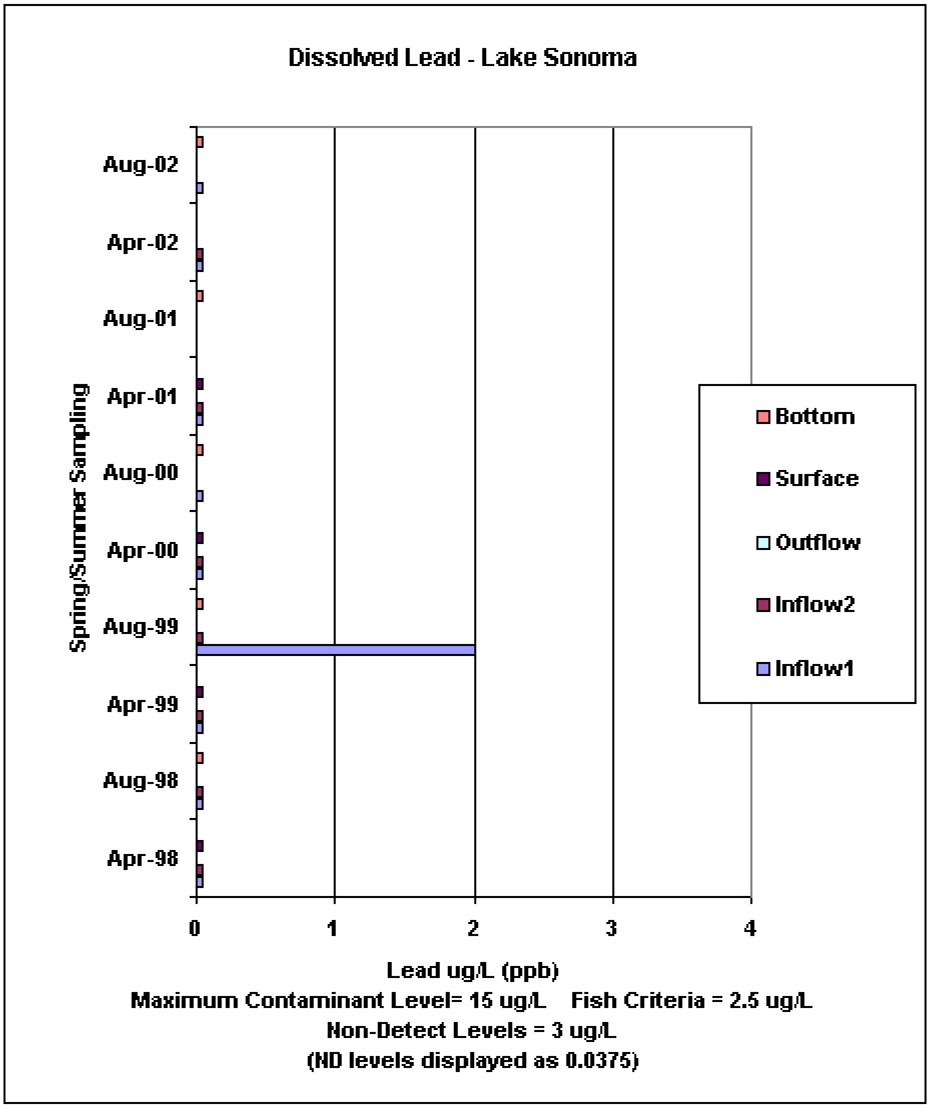
Dissolved Chromium - Lake Sonoma
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
10
12
Chromium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L   Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L   1999 and Beyond = 5 ug/L
(ND levels displayed as 0.125)
Bottom
Surface
Outflow
Inflow2
Inflow1

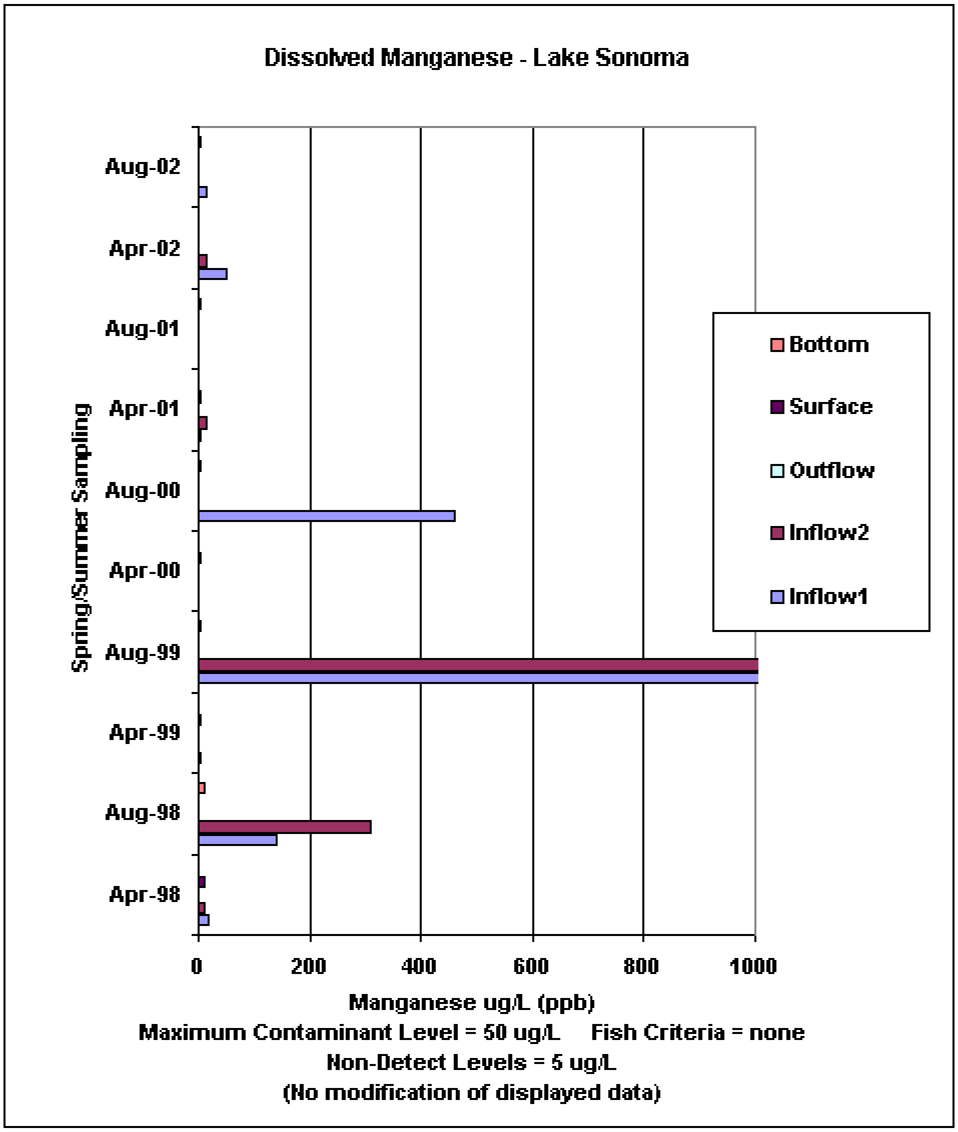


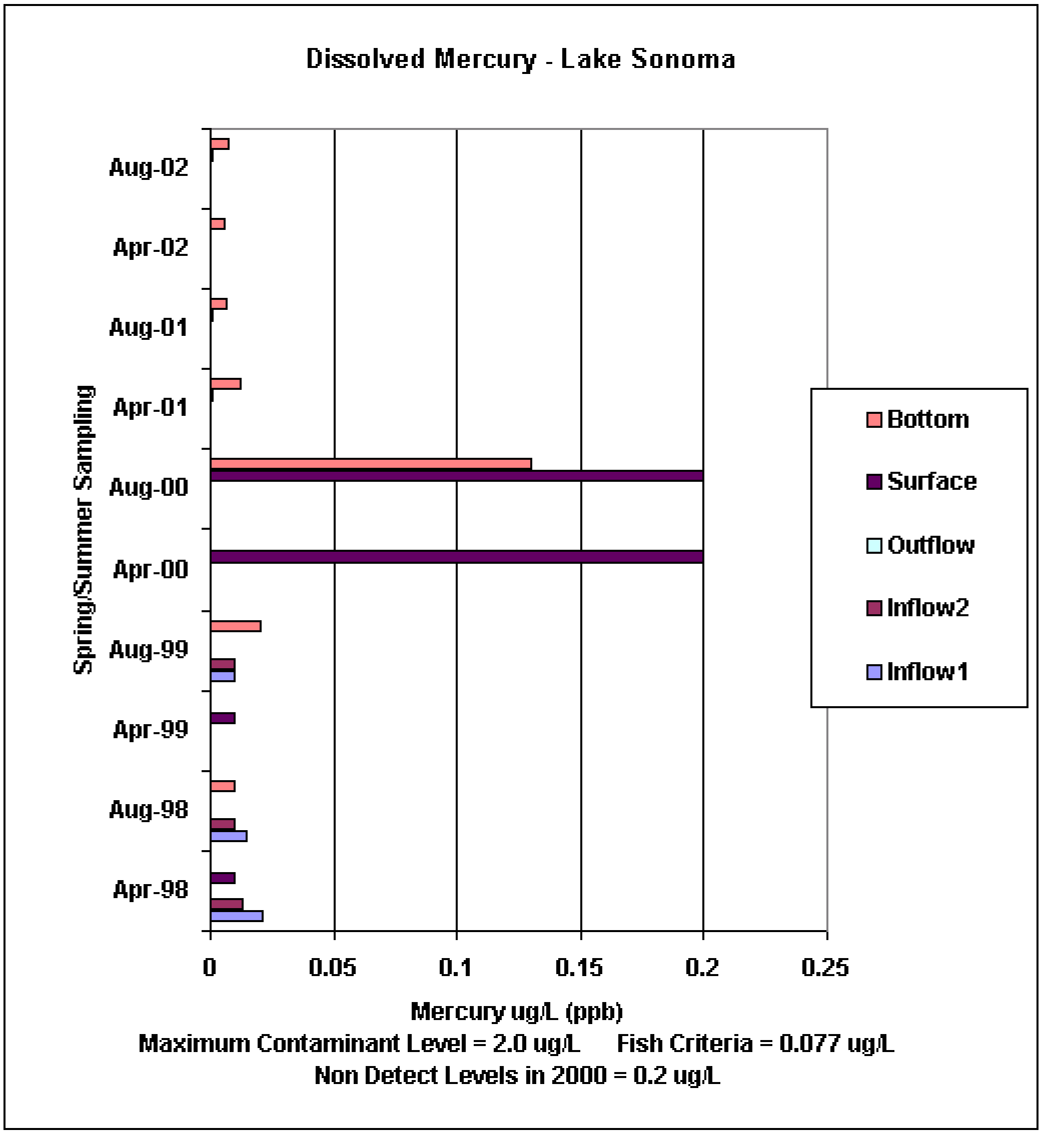
Maximum Contaminant Level = 1300 ug/L Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L
(ND levels displayed as 0.125)

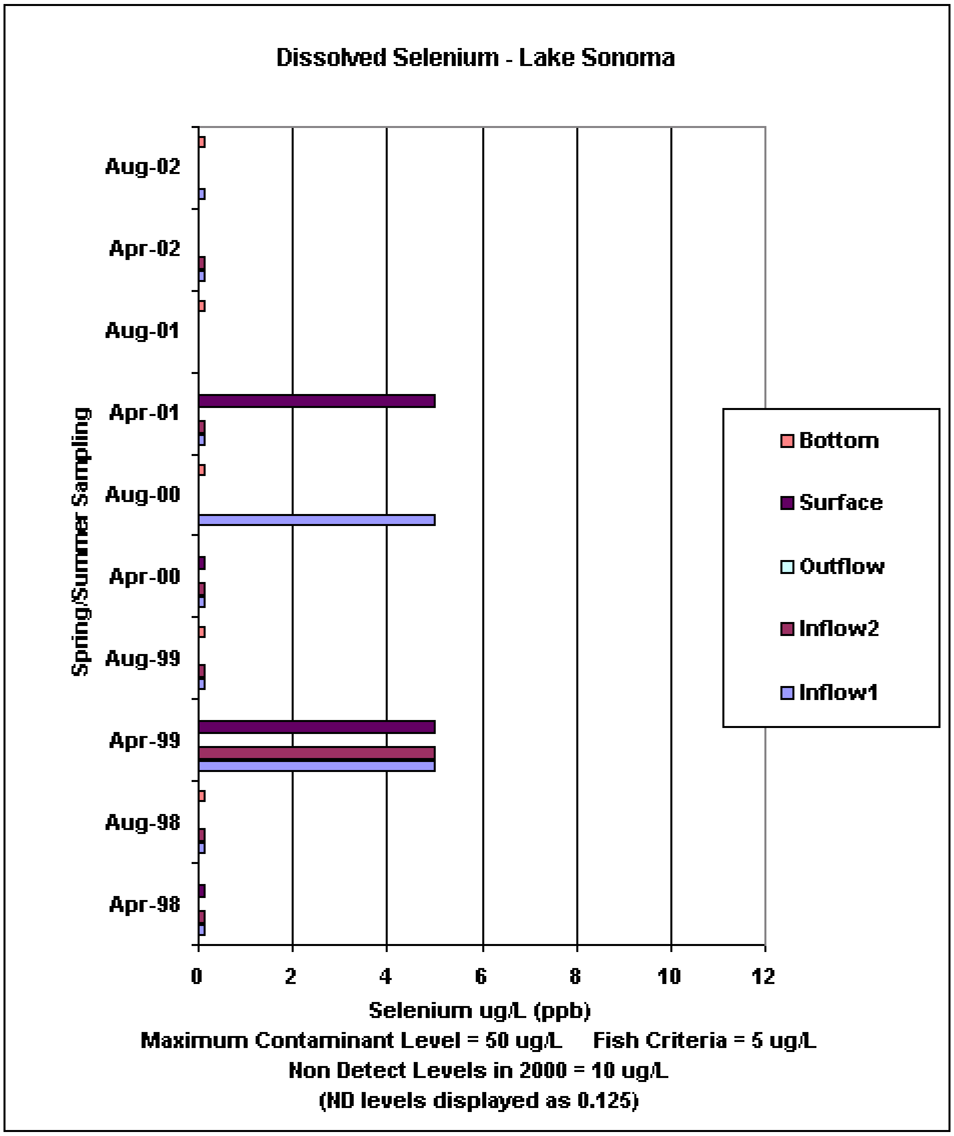


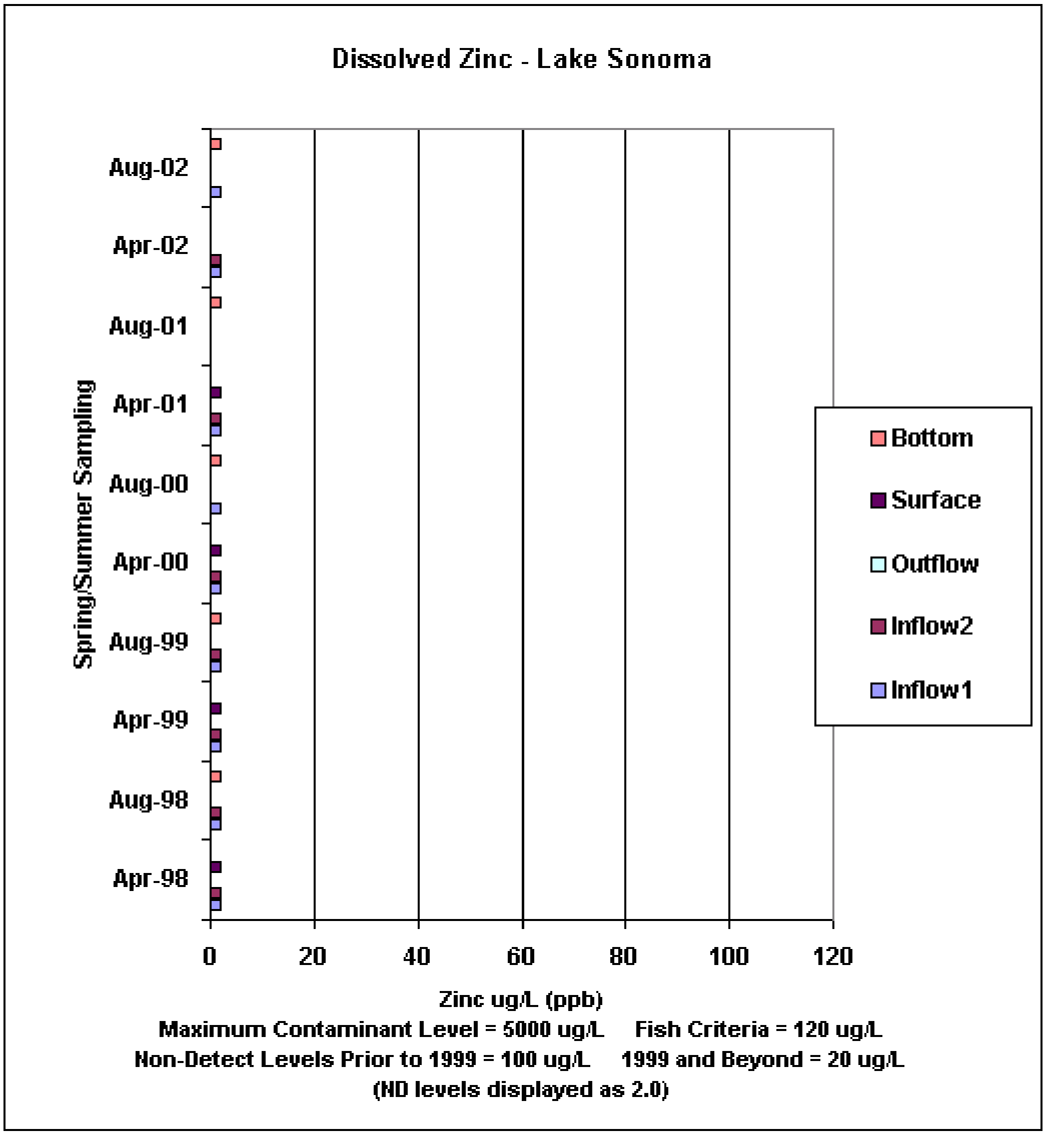
Dissolved Iron - Lake Sonoma
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
100
200
300
400
Iron ug/L (ppb)
Bottom
Surface
Outflow
Inflow2
Inflow1
Maximum Contaminant Level = 300 ug/L   Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L   1999 and Beyond = 50 ug/L
(ND levels displayed as 5)


Dissolved Lead - Lake Sonoma
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
Bottom
Surface
Outflow
Inflow2
Inflow1
0
1
2
3
4
Lead ug/L (ppb)
Maximum Contaminant Level= 15 ug/L Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L
(ND levels displayed as 0.0375)


Dissolved Manganese - Lake Sonoma
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
200
400
600
800
1000
Bottom
Surface
Outflow
Inflow2
Inflow1
Manganese ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = none
Non-Detect Levels = 5 ug/L
(No modification of displayed data)


Dissolved Mercury - Lake Sonoma
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.05
0.1
0.15
0.2
0.25
Bottom
Surface
Outflow
Inflow2
Inflow1
Mercury ug/L (ppb)
Maximum Contaminant Level = 2.0 ug/L Fish Criteria = 0.077 ug/L
Non Detect Levels in 2000 = 0.2 ug/L


Dissolved Selenium - Lake Sonoma
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
10
12
Bottom
Surface
Outflow
Inflow2
Inflow1
Selenium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = 5 ug/L
Non Detect Levels in 2000 = 10 ug/L
(ND levels displayed as 0.125)


Dissolved Zinc - Lake Sonoma
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
20
40
60
80
100
120
Bottom
Surface
Outflow
Inflow2
Inflow1
Zinc ug/L (ppb)
Maximum Contaminant Level = 5000 ug/L Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L 1999 and Beyond = 20 ug/L
(ND levels displayed as 2.0)

Appendix E: Inorganic Sample Data

Inorganic Results (mg/L) For surface lake waters (spring)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity		60	40	50	60	30	40	70	80	20		100
Ammonia		<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Chloride		21	2	21	4	4	3	<1	6	5		4
Nitrate		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1		<0.1
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Sulfate		5.3	2.6	4.2	8.9	2	1	8.2	9	2.1		4.7
Kjeldahl N		0.6	0.1	0.4	0.2	<0.1	0.3	0.2	0.2	0.2		<0.1
COD					<50							
Tot Solids		120	70	100	110	60	78	100	120	21		150

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	100	70	40	50	20	30	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	13	25	3	21	<1	<1	4	<1	6	4	3	2
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	
Sulfate	18	2.1	2.3	3	2.8	1.9	0.8	8.8	11	1.6	11	3.5
Kjeldahl N	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1
COD	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	170	130	59	110	60	60	90	110	150	30	130	90

Inorganic Results (mg/L) For surface lake waters (summer)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	140	70	40	50	50	40	70	90	80	10	80	110
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
Chloride	16	26	4	19	6	5	5	5	9	3	5	8
Nitrate	<0.1	1.5	<0.1	1.3	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1
Total P	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	16	4.1	3.6	3.5	5.9	2	0.7	7.4	14	1.6	6.4	4.4
Kjeldahl N	<0.1	2.7	<0.1	0.4	0.4	0.3	<0.1	0.2	<0.1	<0.1	0.2	0.6
COD	<50	60	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	200	190	50	120	98	80	80	120	120	52	100	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	90	40		60	40	80	100	130	20	110	180
Ammonia												
Chloride	16	490	5		10	8	3	5	14	4	5	22
Nitrate												
Total P												
Ortho P												
Sulfate	16	4.5	3		9.8	3.2	<0.5	6	14	2.7	5.4	8.7
Kjeldahl N												
COD												
Tot Solids	200	1300	50		140	100	100	150	200	50	140	280

Appendix F: MTBE Table

2002 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2002 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	2		2		<2		<2		
Eastman	5				<2				
Englebright	3		3		10		10	10	
Hensley	3		3		3		3		
Isabella	<2	<2	<2	<2	<2	<2	<2	<2	
Kaweah	2		2	<2	8		6	6	
Martis Cr.	<2				<2				
Mendocino	<2				<2				
New Hogan	<2				3				
Pine Flat	<2		<2		2		2		
Sonoma		3	<2		<2		2		
Success	4		4	4	11	12	11	11	

Notes:

1. Non-Detect is indicated by "<2" since the Reporting Limit is 2 ppb or 0.002 ppm.

2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.

3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.

4. For 2002, the number of MTBE water sampling at each lake is based on last year's lab results.

5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was historically non-detectable. The 2002 results of non-detectable levels were similar except Lake Eastman and New Hogan now reported low, detectable levels of MTBE.

6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because of historically low detectable levels of MTBE.

7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because of historically higher MTBE being found. The 2002 results were similar except Isabella now reported non-detectible levels.

8. In 2001, very high MTBE levels were reported at Lake Isabella during the Spring (18 ug/L near the marina) . During Spring 2000, Lake Isabella reported 21 ug/L. The 2002 results indicate that the previous MTBE problem near the marina was not visible during the Spring 2002 sampling event, and may have been rectified.

Appendix G: Fish tissue analysis table

2002 Fish Tissue Results

The following table provides an overview of the lab results for the 2002 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conducting the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The California OEHHA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Mercury Total ppm	FDA Criteria
Black Butte	Sm M Bass	Composite (3)	6/12/02	0.24	0.26	1 ppm
Eastman	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Englebright	Note 5	N/A	N/A	N/A	N/A	
Hensley	Black Bass	Composite (3)	4/23/02	<0.10	0.72	1 ppm
Isabella	Black Bass	Composite (3)	6/4/02	0.20	0.21	1 ppm
Kaweah	Sm M Bass	Composite (3)	7/14/02	0.11	0.53	1 ppm
Martis Cr	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Mendocino	Note 6	N/A	N/A	N/A	N/A	
New Hogan	Lg M Bass	Single (1)	6/3/02	<0.10	0.34	1 ppm
Pine Flat	Note 4	--------------------	-----------	----------	-----------	< Mon 01
Sonoma	Note 6	N/A	N/A	N/A	N/A	
Success	Black Bass	Composite (3)	4/15/02	<0.10	0.18	1 ppm

Notes:

9. Non-Detect is indicated by "<0.02". The lab Detection Limit for mercury is 0.02 ppm.
10. Total Mercury was reported in mg/g or ppm.
11. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.
12. The fish tissue program was terminated at Eastman and Martis Creek in 2001 and in Pine Flat in 2002 due to low total mercury results. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout). For Pine Flat total mercury was 0.21 ppm in 2000 (composite of three Sacramento Sucker fish) and 0.23 in 2001 (composite of three spotted bass).

13. Due to seasonal conditions, a fish could not be successfully collected at Lake Englebright. Another attempt will be accomplished for the 2003 report.
14. Fish were not collected at Mendocino or Sonoma due to communication difficulties.

The above 2002 total mercury results indicate only Hensley is higher than average. However, in 2001, the total mercury results were only 0.30 ppm for Hensley (small mouth bass). The 2003 fish tissue program should provide additional data. EPA fact sheet on fish advisories (EPA-823-F-99-016) indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.

Annual Water Quality Report

SUCCESS LAKE

Water Year 2002

Written by
John J. Baum
Water Quality Engineer
U. S. Army Corps of Engineers
Sacramento District
January 2003

TABLE OF CONTENTS

Success Lake

I. Purpose

This report is part of an environmental monitoring program that began at Success Lake in April 1974. The monitoring program was implemented to determine the level of water quality in the lake for both recreation and environmental health and to satisfy the Department of Army Engineering Regulation 1110-2-8154, "Water Quality and Environmental Management for Corps Civil Works Projects".

II. Brief Description of Success Lake

Success Lake is located in southern central California, 8 miles east of Porterville. The lake is nestled in the southern Sierra Nevada foothills and is surrounded by grasslands and blue oaks. The lake was formed by the construction of a dam on the Tule River that was completed in 1962. The dam is 142 feet high and 3,490 feet across. During the spring run-off season it stores 82,000 acre-feet of water and has a water surface area of 2,450 acres. Since being built by the US Army Corps of Engineers for flood control and irrigation, the lake has become a popular destination for recreation. Summers are warm and the winters mild, allowing for year-round activities.

Generally there are two sample events a year, spring (April) and late summer (August). Since the start of the monitoring program, a water quality report is produced yearly to list results and address any concerns of the previous water year.

Generally Success Lake has a depth of < 100 ft during the sampling events, and is considered a eutrophic (nutrient rich) lake when characterized by its clarity. One of the common characteristics of a eutrophic lake such as Success Lake is that during warm late summer months the bottom depths are low in dissolved oxygen (DO). Additionally Success Lake is warm (>20ºC) in the late summer. Due to both the low DO concentrations and high temperatures, warmwater fish species are best suited to survive in the lake. Warmwater fish species include bass, carp, perch, bluegill, crappie, and catfish. Another characteristic of eutrophic (nutrient rich) lakes is their low water clarity due to algal blooms and sediments suspended by wind action. Water clarity is often measured in terms of Secchi Disc depth or SD (Appendix A). Historically the water clarity in Success Lake has been low (Average SD = 5.34 feet), but 88.5 % of the samples have met the recreational goal of 4 feet or greater (Figure 1). In 2001 both the spring and the late summer Secchi Disc depth measurements were above the goal of 4 feet (2001 Spring SD = 4.5 feet and 2001 Late Summer SD = 4.25 feet).

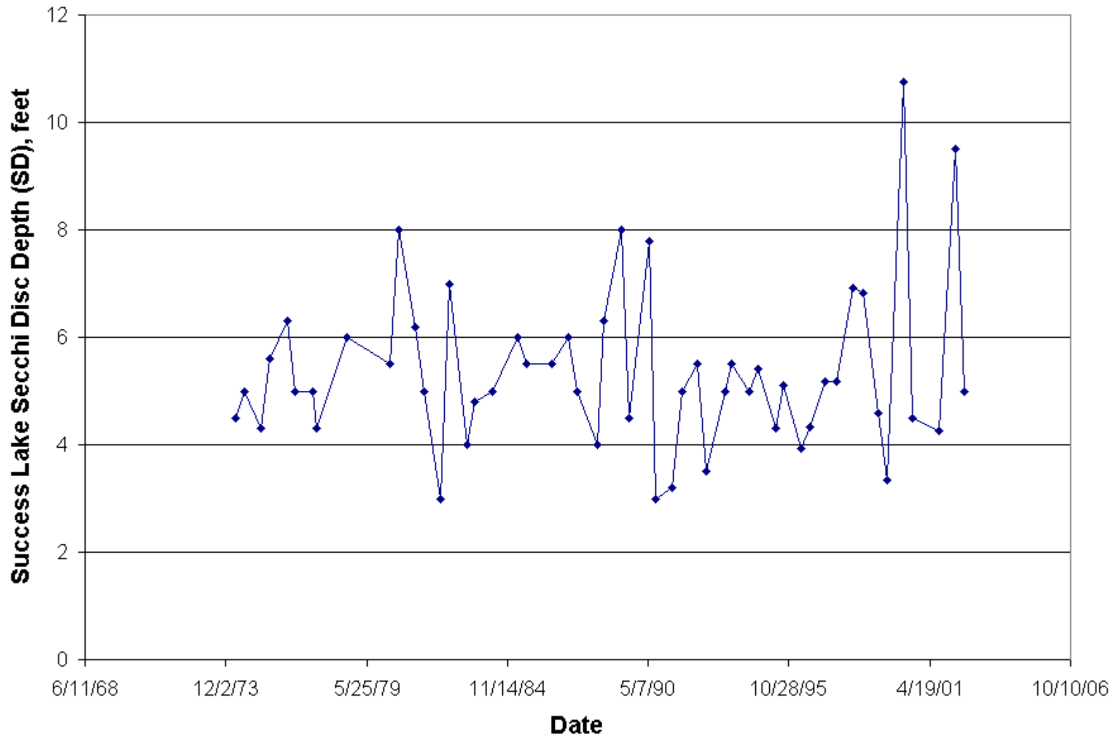


Figure 1. Historical Secchi Depth Values at Success Lake (2002 values included).

The 2001 Water Quality Report listed MTBE levels and dissolved oxygen depletion as areas of concern, and dismissed high concentrations of dissolved iron as being due to isolated to lake bottom samples. While concentrations of MTBE in the spring of 2001 were just above the detection limit of 2 ppb (2001 MTBE Spring = 3 ppb), values were found to be higher during the summer. Concentrations of MTBE near the marina and in the center of Success Lake were 6 ppb.

III. Sample Summaries for this year.

Introduction

The following general summaries are split into their respective sample types. Each type of sample summary includes a discussion of both the spring (April) and late summer (August) samples to better examine trends within the current year. The types of parameters monitored this year include: Secchi Disc depths, water column profiles (temperature, DO and pH), phytoplankton characterization, metals concentrations, MTBE concentrations, Inorganic characterization (alkalinity, phosphorous, nitrogen, etc..), and fish mercury concentrations. For a more detailed explanation of the importance for each type of sample, please see Appendix A.

SECCHI DEPTH

The Secchi Disc depth found during the spring and late summer sampling were similar to previous events. Traditionally the lake varies in its clarity. More often the clarity is better in the spring than in the late summer, but sometimes the late summer is clearer. In spring the water clarity was higher and had a SD of 9.5 feet. The spring SD was the second highest value recorded for Success Lake since beginning the monitoring program. The clarity of Success Lake was highest in spring 2000 (Spring 2000 SD = 10.75 feet). The late summer SD of 5 feet was above the recreational goal of 4 feet and an improvement from last year (Summer 2001 SD = 4.25) (Appendix B).

TEMPERATURE VALUES

The temperature profiles for Success Lake are indicative of a seasonally well-mixed lake. The lake is well stratified in the spring, but ~~the layers~~ disappears by the warm temperatures of late summer. The difference in the depth of the lake between the spring and late summer sampling events was considerable (spring depth = 72.2 feet, late summer depth= 52.5 feet). The average temperatures also were very different (spring average temp. = 13.88 ºC, late summer average temp.= 25.10 ºC) at each sampling event. Success Lake's temperature varies due to its not having a deep-water area to buffer it from the warm summer air temperatures. Due to the warmth of the water, Success Lake may not be able to support coldwater fish species year round. For detailed results obtained during the sampling events, please see Appendix B.

DISSOLVED OXYGEN

The dissolved oxygen (DO) concentration in the lake differs greatly from spring to late summer. In the spring DO concentrations were 7.83 mg/l DO near the surface (@ 1 foot depth) and 3.82 mg/L at the bottom of the lake (72.2 feet). DO concentrations in the late summer are much lower and have a steady gradient from near the surface (DO = 4.40 mg/l @ 1 foot depth) to the bottom of the lake (DO =0.49 mg/l @ 52.5 foot depth). The low DO values at the bottom of the lake are associated the decomposition of waste materials at accelerated rates due to the warm temperatures. Fish species that require greater than 5 mg/l DO at cooler water temperatures (< 20ºC) would be unlikely to survive year round in Success Lake. For detailed results obtained during the sampling events, please see Appendix B.

PH LEVELS

At the spring sample event pH values in the lake were slightly basic (pH = ~7.22) throughout the water column. The pH values in the late summer profile varied widely. The pH was more basic towards the surface and middle waters (max pH = 7.86) and slightly acidic at the bottom (pH = 6.78). The lower pH values at the bottom of the lake increase the likelihood that higher soluble metal concentrations will be in lake bottom samples. For detailed results obtained during the sampling events, please see Appendix B.

PHYTOPLANKTON

In the spring sample, the algal biomass within the lake was much higher (Biomass = 2083.05 μg/L) when compared to spring 2001 (2001 Spring biomass = 427.49 μg/L). In spring 2001 diatoms were the most dominant species, but in spring 2002 dinoflagellates were the dominant species. In late summer the same trend occurred and the phytoplankton population was much lower in summer 2001 (2001 Summer Biomass = 429.02 μg/L) than summer 2002 (Biomass = 3531.12 μg/L). Diatoms were the most dominant species during the 2002 and 2001 late summer sampling events. For detailed results obtained during the 2002 sampling events, please see Appendix C.

METALS

Several metals exceeded their applicable criteria during either the spring or summer. Iron and manganese in summer lake bottom samples were above secondary MCL's that are based on aesthetics, but iron exceeded even fish criteria. Selenium in a late summer sample of water flowing into the lake also exceeded the fish criteria (5 ppb), although ambient lake values were lower. For detailed results obtained during the sampling events, please see Appendix D.

Dissolved iron concentrations in Success Lake have been historically high. While samples generally don't exceed the secondary MCL (300 ppb) or the instantaneous maximum fish criteria (1000 ppb), the late summer 2002 lake bottom iron concentration (1700 ppb) did exceed both ~~limits~~. There are no results for spring lake bottom concentrations, but the concentrations of both of the lake inflows (South Fork Tule River and the North Fork Tule River) were elevated (100 ppb and 60 ppb).

In late summer 2002, water at the bottom of the lake had a manganese concentration of 460 ppb. This was the highest manganese concentration since the summer bottom sample in 2000 (660 ppb). The concentration was above the secondary Maximum Contaminant Level (MCL manganese = 50 ppb). Exceeding the secondary manganese MCL is not seen as an area of concern due to it being based on aesthetic preferences rather than health effects.

Selenium was found at an elevated concentration in the North Fork of the Tule River (just upstream of Success Lake) during the late summer sampling event. The river sample had a selenium concentration of 6 ppb, which is greater than the fish criteria limit (5 ppb) but far less than the MCL (50 ppb). In the last five years of sampling (1998 –

2002, twice a year) only two samples have shown elevated concentrations of selenium and both were from the same location, North Fork of the Tule River. The Tule River sampling site will be monitored closely in 2003.

MTBE

Concentrations for MTBE around the lake were found to be 4 ppb during the spring but increased in late summer sampling to a maximum of 12 ppb near the dam very nearly equaling the California MCL for this substance. The spring 2002 results were close to the MTBE concentrations found during both spring and late summer sampling events in 2001 (4-5 ppm). In late summer 2000 the concentrations of MTBE in the lake were 9 ppm, which is more similar to the 2002 results. For detailed results obtained during the sampling events, please see Appendix F.

INORGANIC ANALYSIS

Results for the spring and late summer inorganic analysis were within historic and expected ranges, and the only parameters to note are the alkalinity, chloride, and total solids concentrations in waters flowing into the lake during the summer. For detailed results obtained during the 2002 sampling events, please see Appendix E.

The alkalinity results for inflowing water samples in Spring (50 mg/L CaCO3) and Summer (180 mg/L CaCO3) at Success Lake indicated a dramatic increase. The 2002 summer lake inflow sample had the highest alkalinity concentration of all the lakes monitored by the USACE for the last three years.

The chloride concentration of water flowing into the lake was 22 mg/L compared to 2 mg/L seen in the spring sample. Concentrations of chloride in the lake during the spring and summer 2002 sampling events were 4 mg/L and 8 mg/L respectively.

The total solids in the lake were characteristically high during the summer sampling event (170 mg/L), but the total solids concentration in water flowing into the lake during the summer were higher than expected at 280 mg/L.

FISH TISSUE ANALYSIS

Fish tissue analysis for total mercury was performed on a composite sample composed of tissue from three small mouth bass collected in April 2002. The composite sample had a resulting total mercury concentration of 0.18 ppm. This is below both the U.S. F.D.A. criteria for a fish advisory (1 ppm) and the California Office of Environmental Health Hazard Assessment (OEHHA) screening value to continue monitoring (0.3 ppm). The 2002 composite sample had a lower mercury concentration than the 2000 event (0.32 ppm) and the 2001 (0.29 ppm) composite sample. For detailed results obtained during the sampling events, please see Appendix G.

IV. Conclusions

Success Lake is a moderately eutrophic lake that can support warmwater fish species. Coldwater fish that require temperatures below 20 C and dissolved oxygen concentrations greater than 5 mg/L may have difficulties surviving year round at Success Lake.

Contaminants of concern in Success Lake for 2002 are dissolved iron and MTBE during summer conditions which is in a premonitory status. There are also concerns about the concentration of dissolved selenium, chloride, and total dissolved solids in water flowing into the lake during the summer. Additionally the concentration of dissolved oxygen in the lake is low year round. For the summer 2002 sampling event no part of the water column was above the recommended 5 mg/L DO concentration.

V. References

North American Lake Management Society (1990). *Lake and Reservoir Restoration Guidance Manual*, EPA 440/4-90-006, U.S. Environmental Protection Agency, Washington, DC.

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Welch, E.B. (1992) *Ecological Effects of Wastewater: Applied limnology and pollutant effects,* Chapman and Hall, Cambridge University Press, Great Britain.

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VI. Appendices

Appendix A: Glossary of Sample Types

Glossary of Sample Types

This glossary of sample types is intended to provide a general background and indicate the importance of each sample in determining water quality. These are meant to be brief and basic. If a further explanation is desired please refer to the list of references provided in this report.

Secchi Depth

One of the oldest and easiest methods to determine lake clarity is the Secchi depth (SD). The Secchi depth is determined by dropping a Secchi disc into a water body and determining the depth that it is last visible from the surface of the water. Secchi discs are generally white and 20 cm in diameter. Secchi depth values are most impacted by the light intensity at the time of sampling and the scattering of light by solid particulates within the water column. Algal growth (phytoplankton) and sediment re-suspension are often major constituents of solid particulates within the water column. Secchi depth values can be used to estimate the Trophic state or the nutrient levels within the lake. The more nutrients are available, the larger likelihood of algal blooms that limit water clarity. Due to recreational concerns for safety, the goal for Secchi depth values is four feet or greater.

Temperature Profiles and Data Points

The temperature profile of a lake provides information how a lake is operating and the potential for aquatic biota to live within the lake. The temperature profile is a direct indicator if a lake is stratified. Stratification in lakes is created generally by temperature affecting the density of water molecules. Stratification is usually indicated by a region of similar temperature nearer the surface of the water (epilimnion), then a region of temperature transition (metalimnion), to another layer of nearly constant temperature at the bottom of the lake (hypolimnion). Each layer in a stratified lake is important, but the existence of a hypolimnion can drastically impact how well a lake can handle warmer temperatures such as those found in northern California during the summer. The hypolimnion acts as a buffer against large temperature shifts. The nature of dam operation is that water is discharged near the bottom, releasing the hypolimnion, and eliminating stratification. This operation limits the ability of reservoirs to regulate their temperature during the summer months. Stratification isn't always desirable. When a lake isn't stratified and is instead well mixed, the required nutrients near the bottom of the lake become available to phytoplankton for growth. Temperatures within lakes also indicate which species of fish will survive within a lake. Coldwater species of fish require temperatures below 20 degrees C in order to spawn and survive. If a lake is often above 20 degrees C, then only warmwater fish species will survive.

Dissolved Oxygen (DO) Concentration Profiles

DO is required by organisms for respiration and for chemical reactions within lake waters. The recommended level for DO for most aquatic species survival is 5mg/L. In lakes, biota waste (detritus) falls to the bottom of the lake to be utilized by bacteria. The

bacteria need oxygen and will deplete levels near the bottom of a lake, especially during warm temperature, high respiration conditions. For nutrient rich (eutrophic) lakes more organisms will grow, create wastes, and cause oxygen depleted regions at the lowest areas. Under these conditions only aquatic species that can survive low DO conditions in warm water near the surface will survive.

PH Profiles

The pH profiles of the lakes indicate the potential for certain chemical reactions to occur. In high pH (greater than pH = 7 or basic) aquatic systems, metal pollutants tend to form into insoluble compounds that fall onto the lake floor. In low pH (less than pH = 7 or acidic) systems or areas metal ions become soluble and available for uptake into aquatic organisms. Other compounds like ammonia that are introduced into a low pH aquatic environment will transform into soluble nitrate and be utilized by organisms.

Phytoplankton Analysis

Phytoplankton analysis indicates the health, nutrients, and biodiversity within a lake. Lakes that have few nutrients available (Oligotrophic) will generally have a much lower quantity of phytoplankton (high Secchi depth) but the number of phytoplankton species seen will be large. In a lake that is nutrient rich (eutrophic) there are generally large phytoplankton blooms (low Secchi depth), but they are made up of a couple of phytoplankton species. Certain species of phytoplankton are preferred food sources for zooplankton (small invertebrates). Generally species like diatoms and green algae can be consumed by the filter-feeding zooplankton, but species like bluegreen algae are low in nutrients and are difficult to consume. Some species like the dinoflagellates can grow horn like points to discourage potential predators. In nutrient rich waters where there is plenty of phosphorous, nitrogen can be limited for biological growth. While most species can't grow due to the lack of nitrogen, bluegreen algae (cyanobacteria) have the ability to utilize nitrogen from the atmosphere when required. This gives bluegreen algae the ability to dominate in many eutrophic lakes.

Soluble Metals Analysis

The soluble metals analysis indicates the exposure of humans and aquatic organisms to toxic metals. These metals often build up as they are consumed through the food chain. Water samples provide an indicator for additional problems. Soluble forms of metal ions are more prevalent in low pH (pH <7, or acidic) environments.

MTBE Analysis

MTBE (methyl tertiary-butyl ether) is a chemical additive to gasoline to improve combustion. Due to its high solubility, MTBE travels and blends into aquatic systems rapidly. While not found to be extremely hazardous at low levels, the offensive smell and taste is detectible by humans at extremely low concentrations. The effect of MTBE on humans and aquatic systems is still under investigation.

Inorganic Analysis

Alkalinity

Alkalinity is measured in terms of mg/L of calcium carbonate. It indicates a lakes ability to buffer incoming acidic pollution and situational changes.

Ammonia

Ammonia is a gas that is toxic to fish and is more visible at a higher pH. Ammonia is created through anthropogenic inputs, bacteria cell respiration, and the decomposition of dead cells. Due to being a gas, given time ammonia will volatilize from the water. At a lower pH, much of the ammonia is converted to ammonium (a nutrient for root bound plant life) and utilizes DO in the nitrification process.

Chloride

The chloride ion is an indicator of any salinity increases within a lake. Most fresh water aquatic species are sensitive to salinity changes.

Nitrate

Nitrate is the nitrogen product created through the nitrification of ammonium. Nitrate is a soluble form of the nutrient nitrogen and is utilized by phytoplankton.

Total Phosphorous

The total phosphorous provides a measure of both utilized and soluble phosphorous within water samples. Phosphorous is a required nutrient for plant growth and development.

Ortho Phosphorous

Ortho phosphorous is the soluble form of phosphorous that is utilized by free-floating aquatic plants (phytoplankton).

Kjeldahl N

Kjeldahl nitrogen or total Kjeldahl nitrogen (TKN) is a measure of the total concentration of nitrogen in a sample. This includes ammonia, ammonium, nitrite, nitrate, nitrogen gas, and nitrogen contained within organisms.

COD

Chemical Oxygen Demand (COD) is a measure of the total oxygen required to complete the chemical and biological demands of a sample.

Fish Tissue Analysis

Fish tissue is analyzed to examine potential exposure of humans to toxicants as well as the health of the aquatic food chain. In aquatic systems toxic contaminants can build up (or bioaccumulate) within animals at the top of the food chain. Contaminants (especially organic pollutants) are retained within the fat tissue of an organism, therefore in fish samples the lipid content is often measured.

Lake Code Designation

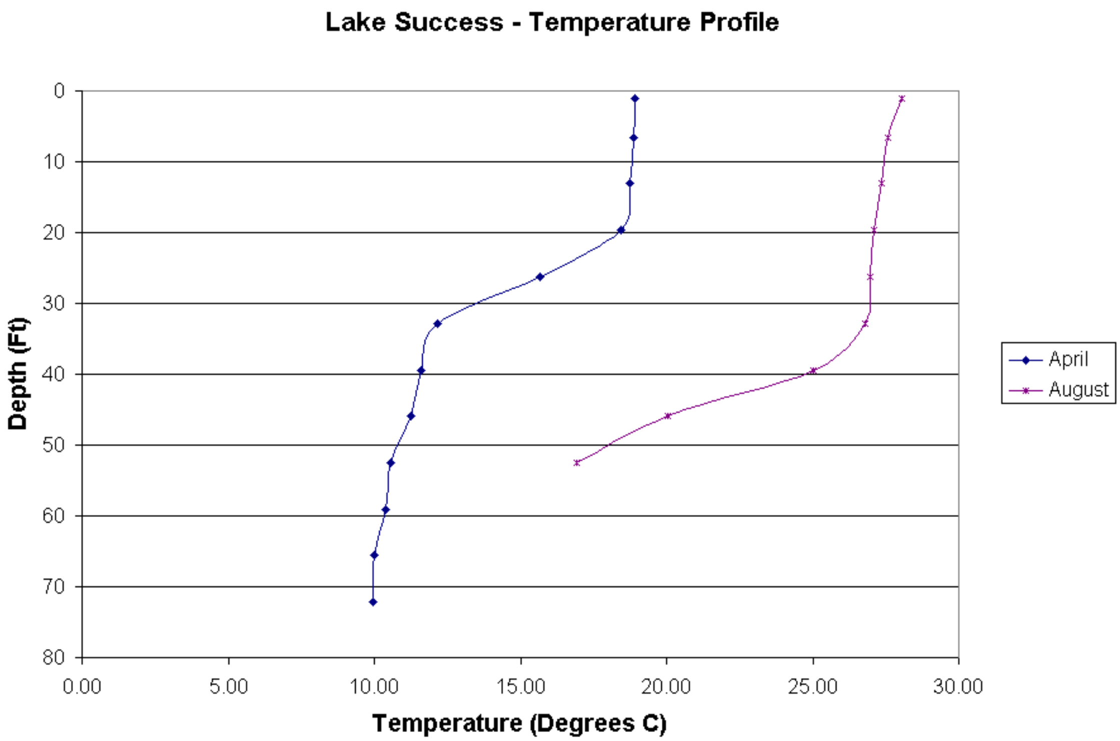
Laboratory Reports are provided in the previous sections.

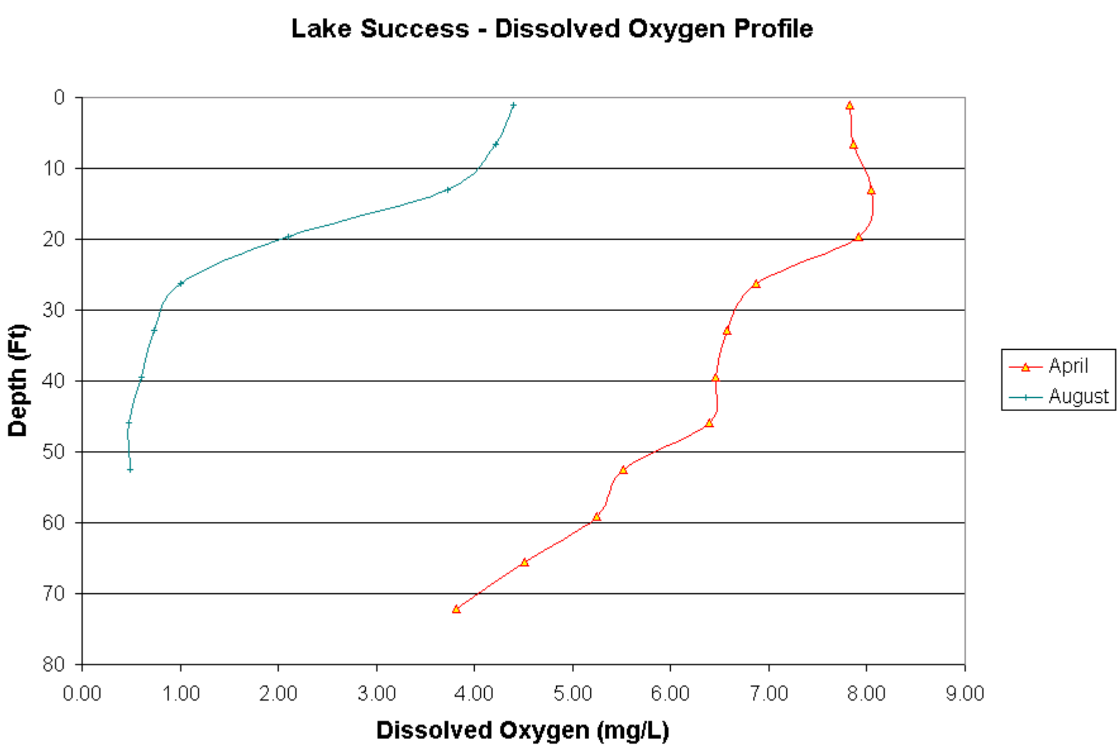
Sample ID is "XX-YY-ZZ" where

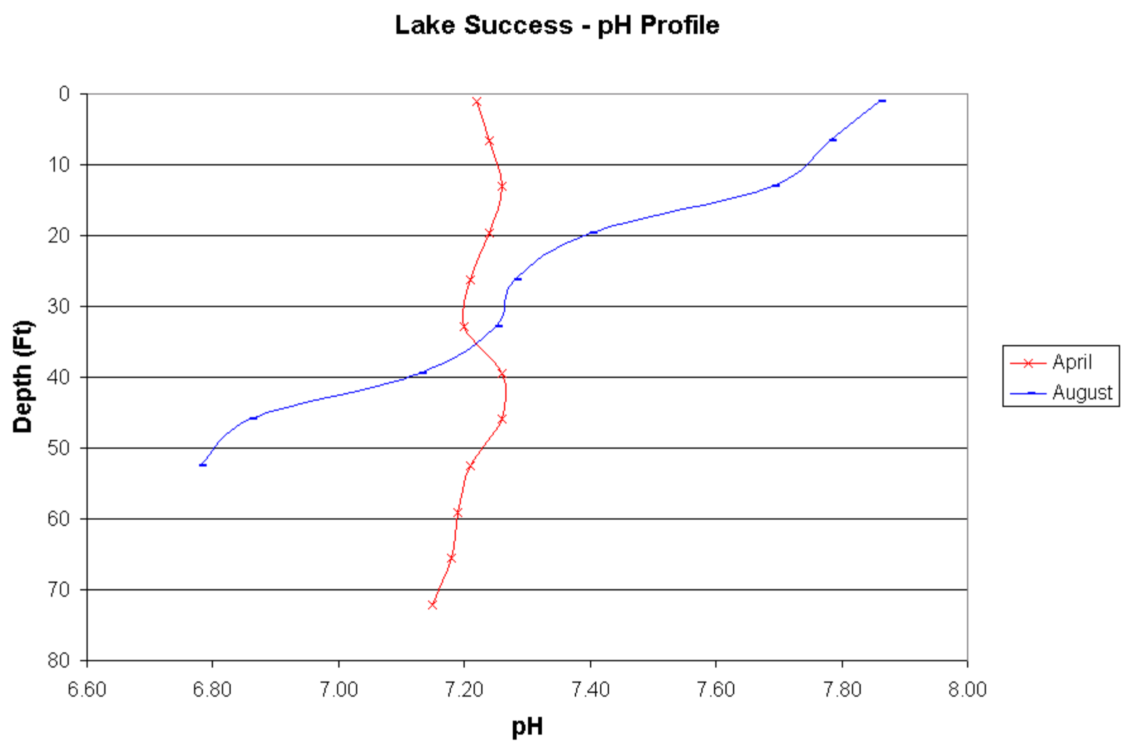
XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summar	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

Example: BB-SU-S is for a water sample taken from Black Butte in the Summer on the Lake's Surface.

Appendix B: Profile Data and Charts (Secchi Disc, Temperature, DO, and pH)


Lake Success - Temperature Profile
Depth (Ft)
0
10
20
30
40
50
60
70
80
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Temperature (Degrees C)
April
August

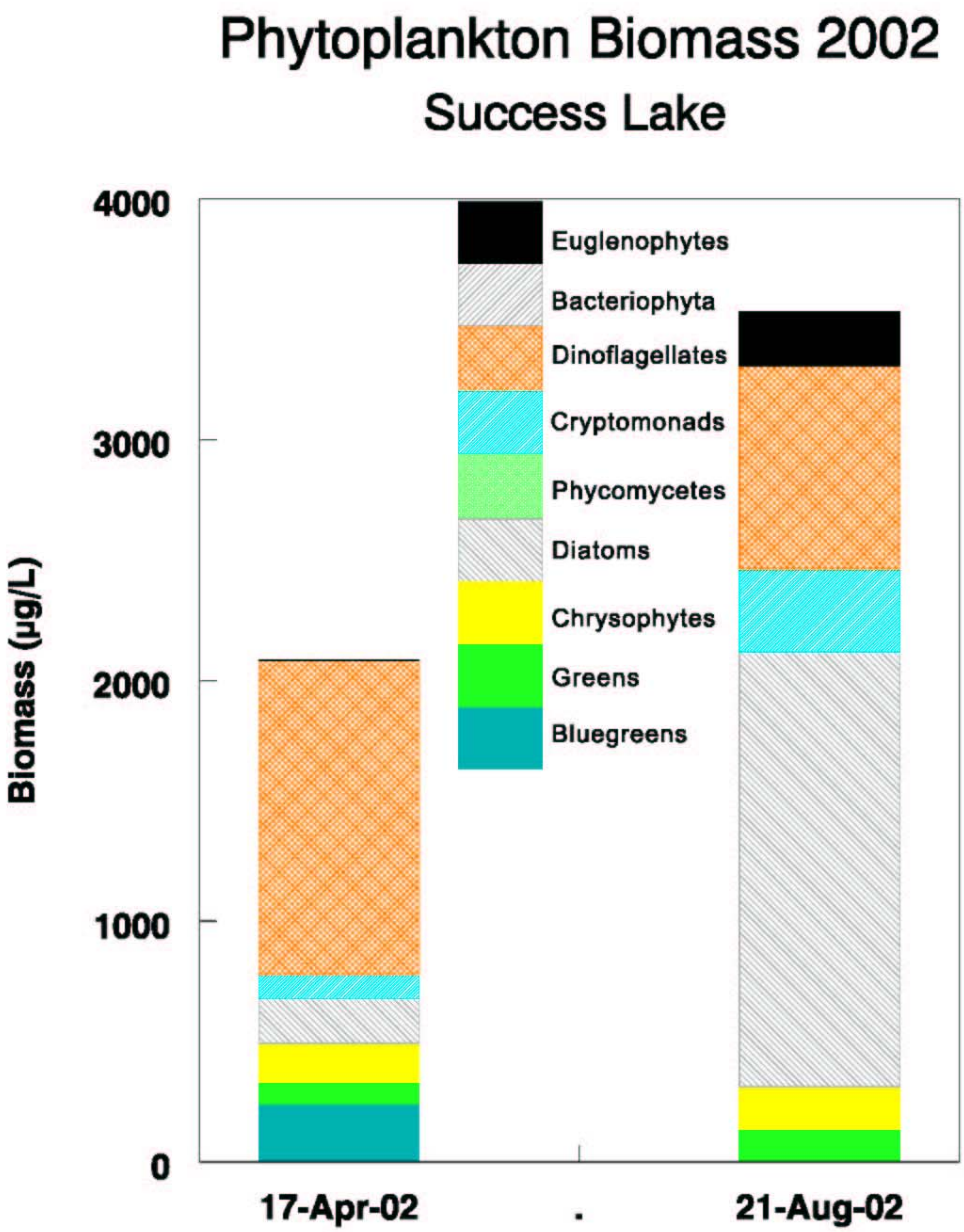

Lake Success - Dissolved Oxygen Profile
Depth (Ft)
0
10
20
30
40
50
60
70
80
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Dissolved Oxygen (mg/L)
April
August


Lake Success - pH Profile
Depth (Ft)
pH
0
10
20
30
40
50
60
70
80
6.60
6.80
7.00
7.20
7.40
7.60
7.80
8.00
April
August

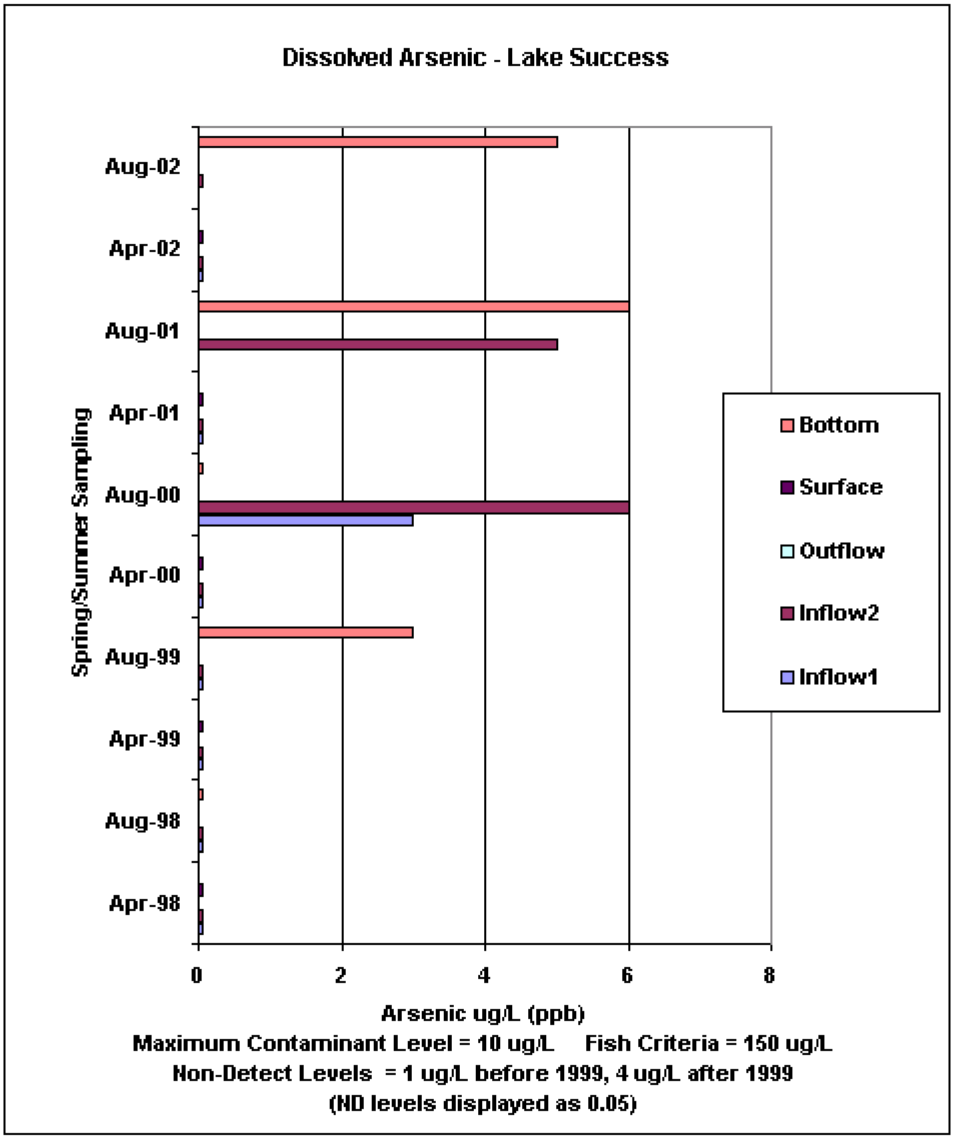
SUCCESS					
Sample Location: Behind dam				**Date:** 4/17/02	
Observers: Tim McLaughlin				**Time:** 2:00 pm	
Lake Elevation: 678.29					
Weather Conditions:					
Wind Speed (mph): 5		**Precipitation:** 0.3		**Temp (F):** 65	
SECCHI Depth: 9 feet and 6 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
21.5	72.2	9.94	205	3.82	7.15
20	65.6	10.01	205	4.51	7.18
18	59.1	10.40	202	5.25	7.19
16	52.5	10.56	199	5.52	7.21
14	45.9	11.27	195	6.40	7.26
12	39.4	11.59	187	6.46	7.26
10	32.8	12.15	168	6.58	7.20
8	26.2	15.68	167	6.87	7.21
6	19.7	18.43	168	7.92	7.24
4	13.1	18.75	169	8.05	7.26
2	6.6	18.86	172	7.87	7.24
0.03	1	18.93	172	7.83	7.22
SOUTH FORK TULE (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
55.6	7.27		-	-	45
NORTH FORK TULE (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
55.2	7.42		-	-	-
VISUAL OBSERVATIONS:					

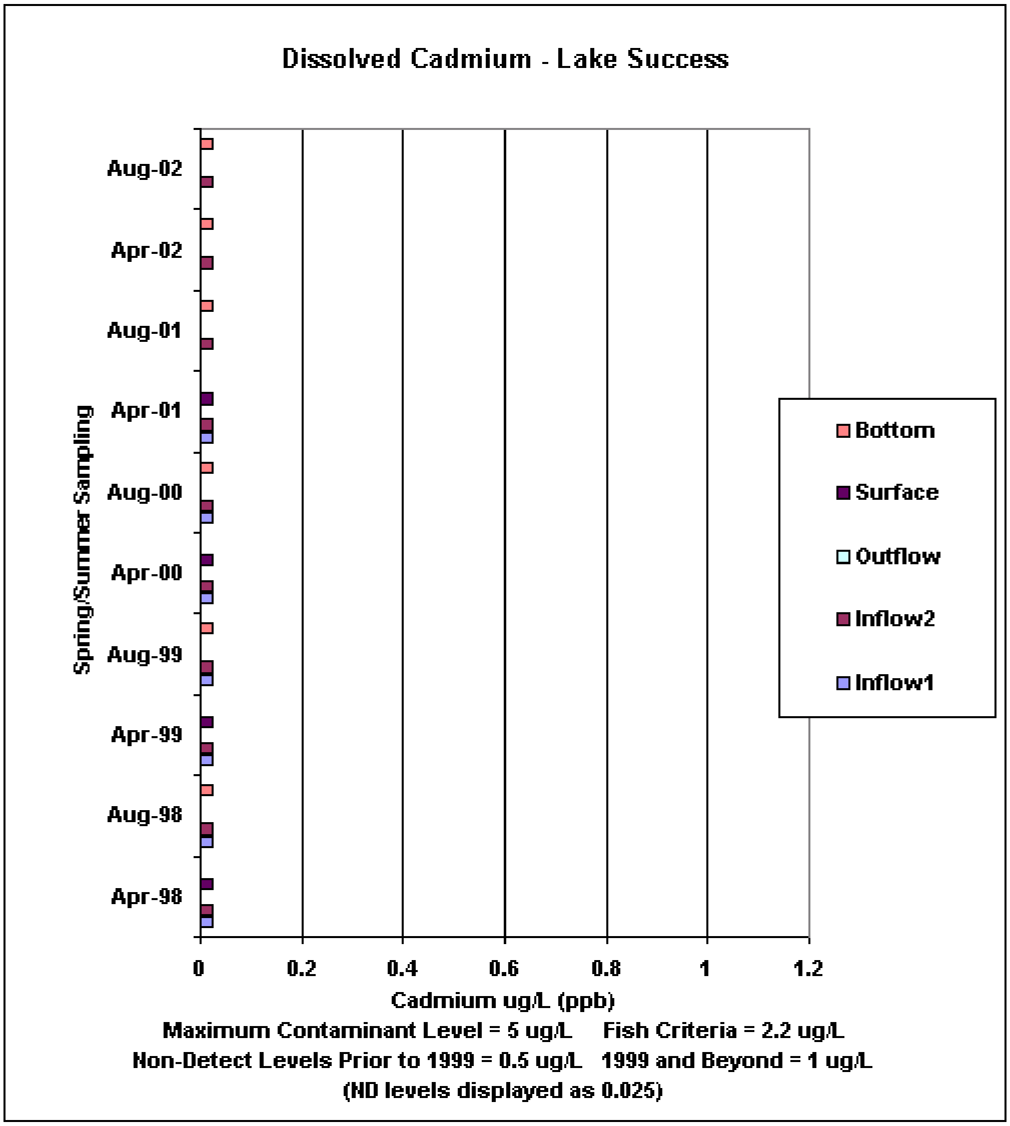
SUCCESS					
Sample Location: Behind dam				**Date:** 8/21/02	
Observers: Tim McLaughlin				**Time:** 2:00 pm	
Lake Elevation: 597.05					
Weather Conditions:					
Wind Speed (mph): 15		**Precipitation:** 0		**Temp (F):** 80	
SECCHI Depth: 5 feet					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
15.8	52.5	16.92	291	0.49	6.78
14	45.9	20.04	256	0.48	6.86
12	39.4	25.01	249	0.61	7.13
10	32.8	26.80	246	0.74	7.25
8	26.2	26.98	246	1.01	7.28
6	19.7	27.10	246	2.10	7.40
4	13.1	27.37	244	3.73	7.69
2	6.6	27.58	244	4.21	7.78
0.03	1	28.06	243	4.40	7.86
SOUTH FORK TULE (Inflow) - DRY					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
-	-		-	-	-
NORTH FORK TULE (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs**
76.8	7.54		-	-	-
VISUAL OBSERVATIONS: Slight hydrogen sulfide smell.					

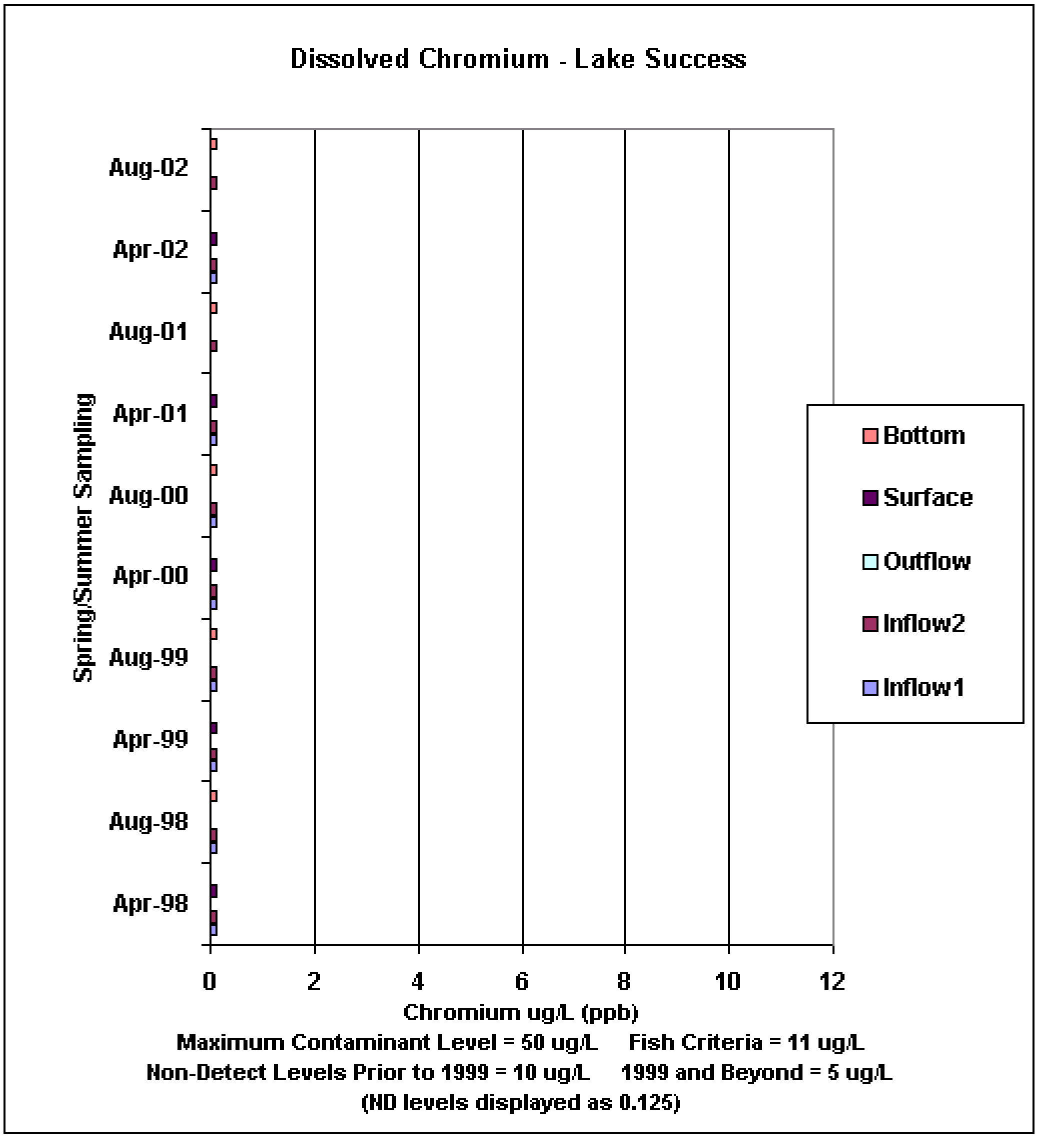
Appendix C: Phytoplankton Data and Charts


Phytoplankton Biomass 2002
Success Lake
Biomass (µg/L)
4000
3000
2000
1000
0
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
17-Apr-02
.
21-Aug-02

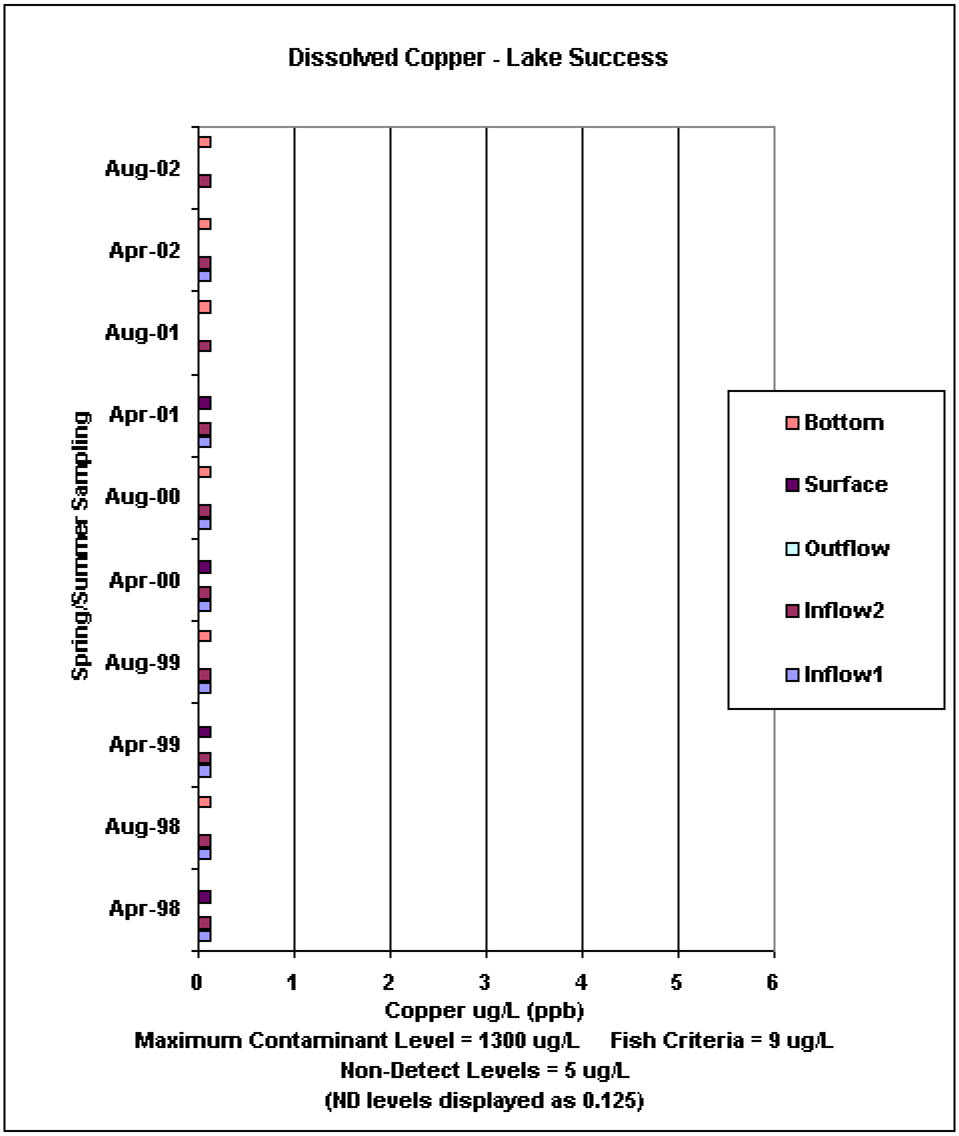
Appendix D: Metals Data and Charts

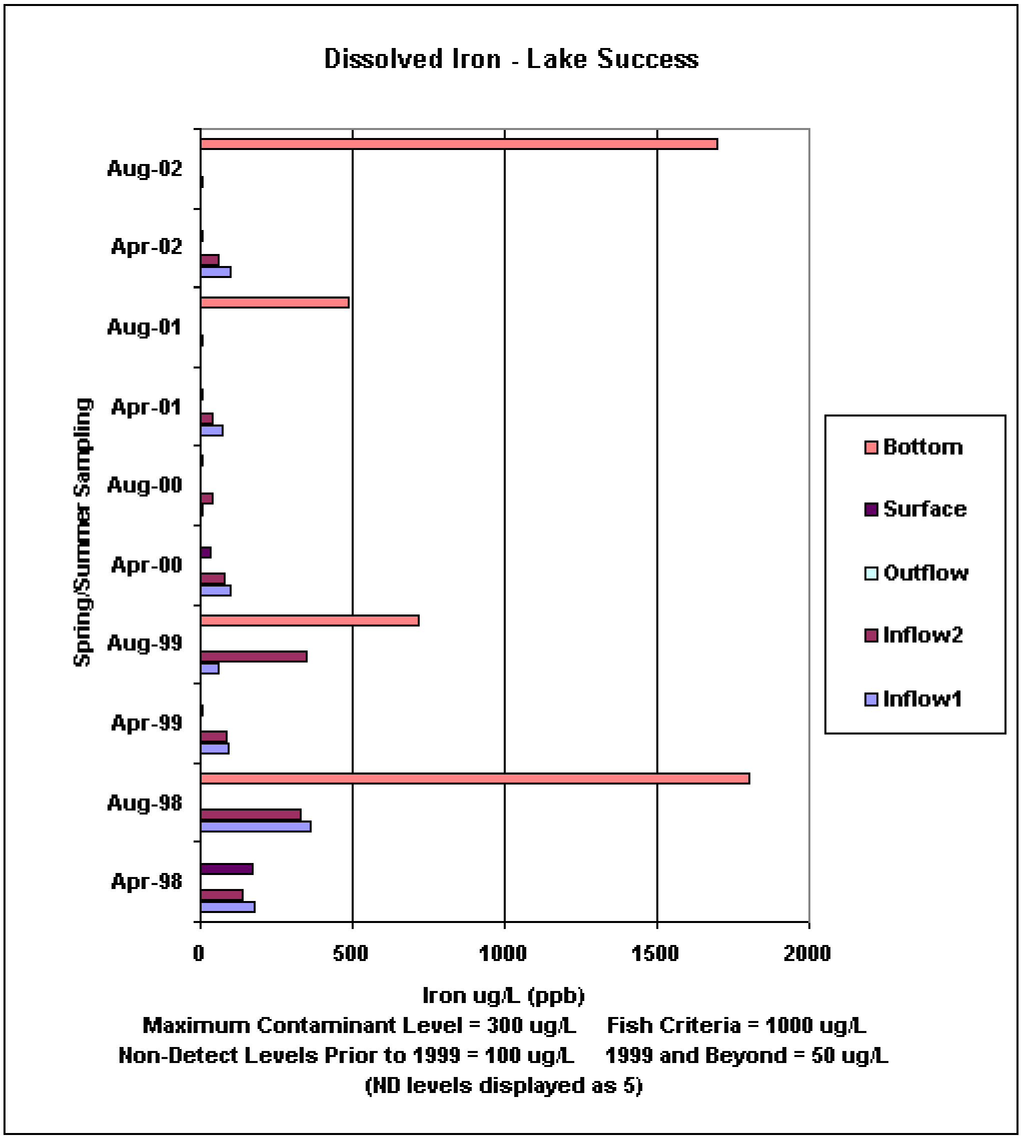

Dissolved Arsenic - Lake Success
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
2
4
6
8
Bottom
Surface
Outflow
Inflow2
Inflow1
Arsenic ug/L (ppb)
Maximum Contaminant Level = 10 ug/L Fish Criteria = 150 ug/L
Non-Detect Levels = 1 ug/L before 1999, 4 ug/L after 1999
(ND levels displayed as 0.05)


Dissolved Cadmium - Lake Success
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
0.2
0.4
0.6
0.8
1
1.2
Cadmium ug/L (ppb)
Maximum Contaminant Level = 5 ug/L Fish Criteria = 2.2 ug/L
Non-Detect Levels Prior to 1999 = 0.5 ug/L 1999 and Beyond = 1 ug/L
(ND levels displayed as 0.025)
Bottom
Surface
Outflow
Inflow2
Inflow1

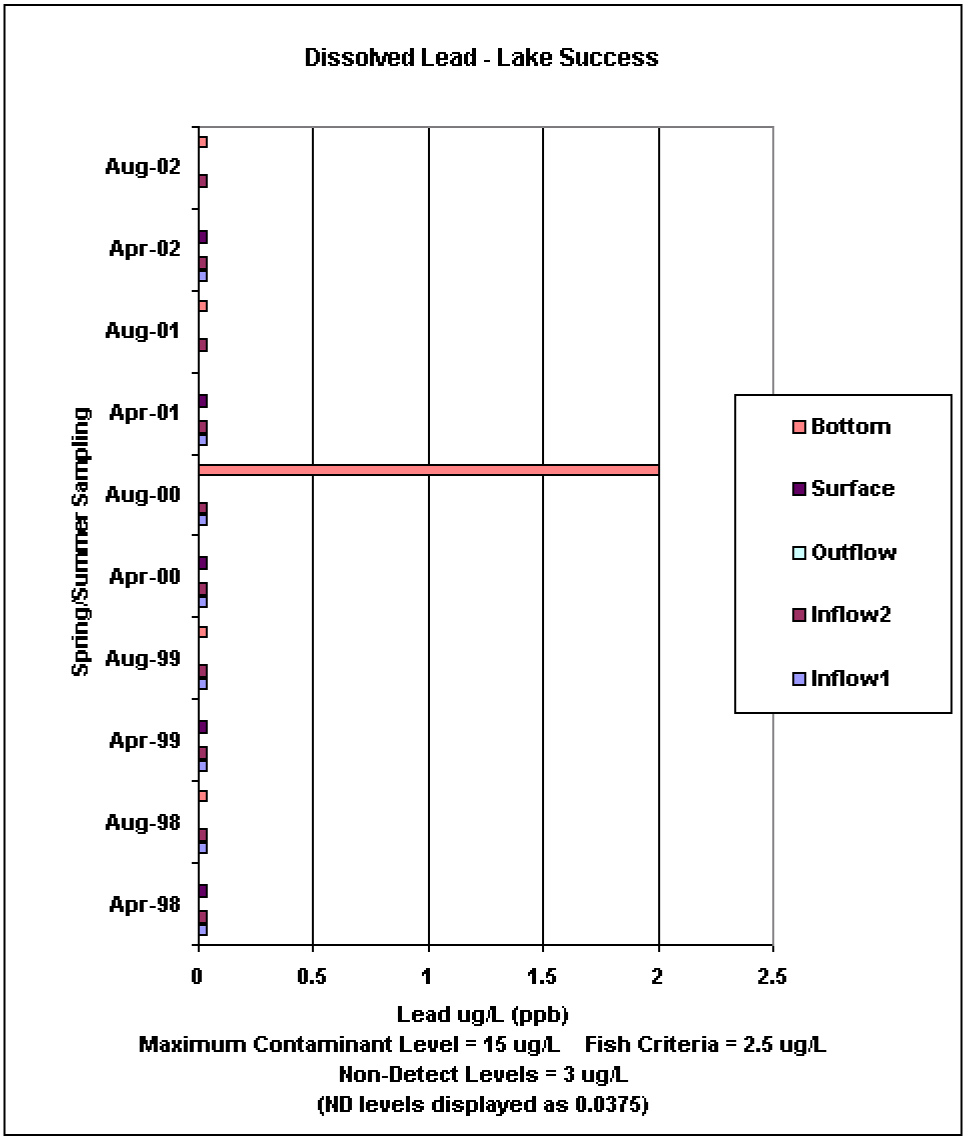


Dissolved Chromium - Lake Success
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
10
12
Chromium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L 1999 and Beyond = 5 ug/L
(ND levels displayed as 0.125)
Bottom
Surface
Outflow
Inflow2
Inflow1

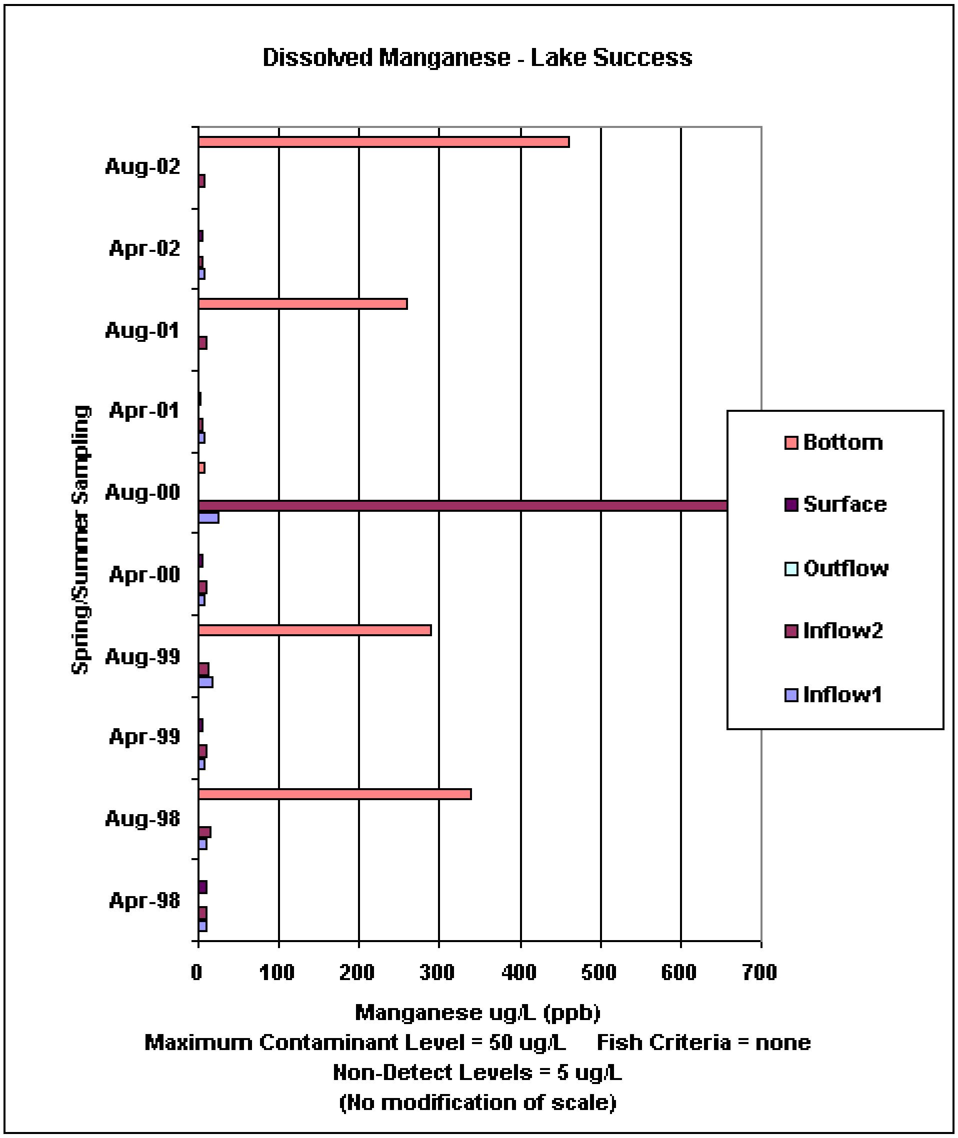

Dissolved Copper - Lake Success
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
1
2
3
4
5
6
Copper ug/L (ppb)
Maximum Contaminant Level = 1300 ug/L
Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L
(ND levels displayed as 0.125)
Bottom
Surface
Outflow
Inflow2
Inflow1



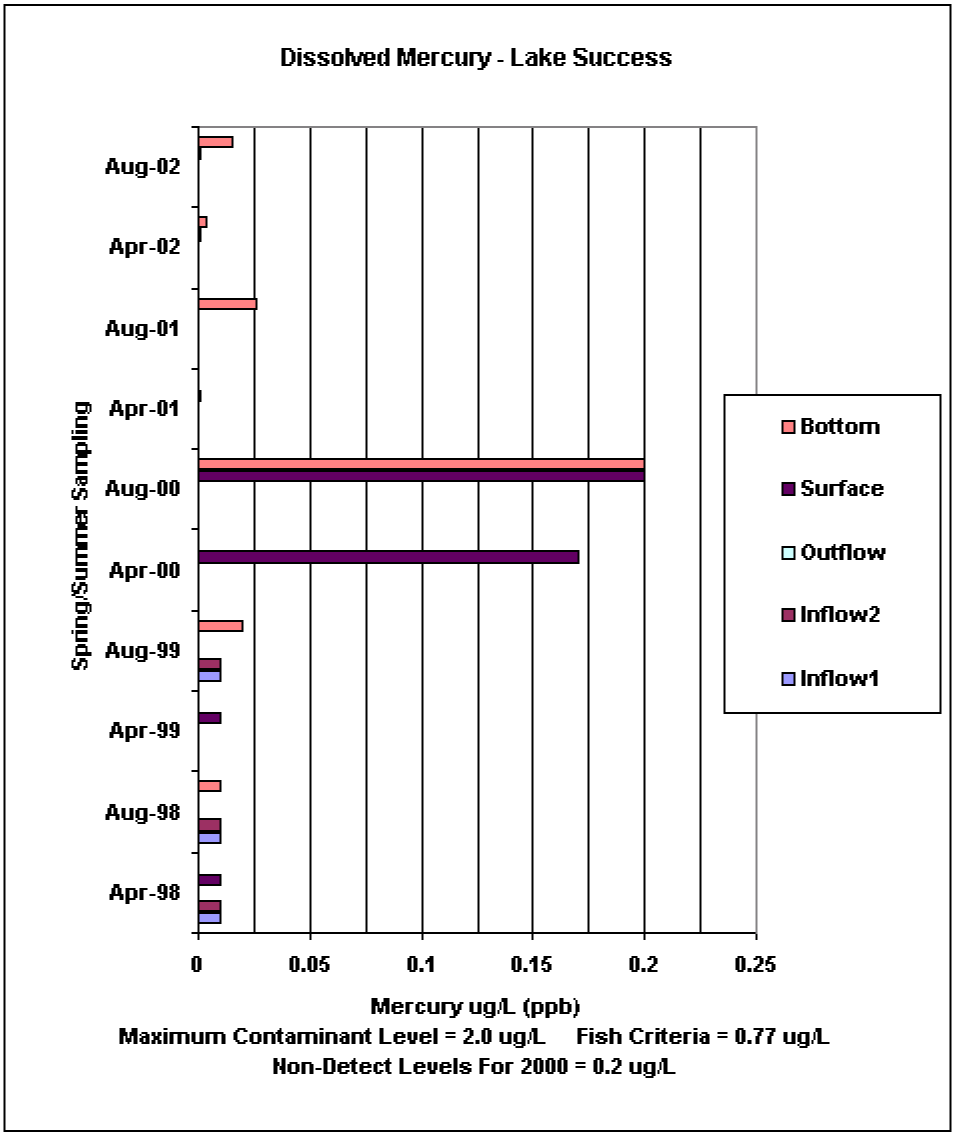
Dissolved Iron - Lake Success
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
500
1000
1500
2000
Iron ug/L (ppb)
Maximum Contaminant Level = 300 ug/L Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L 1999 and Beyond = 50 ug/L
(ND levels displayed as 5)
Bottom
Surface
Outflow
Inflow2
Inflow1



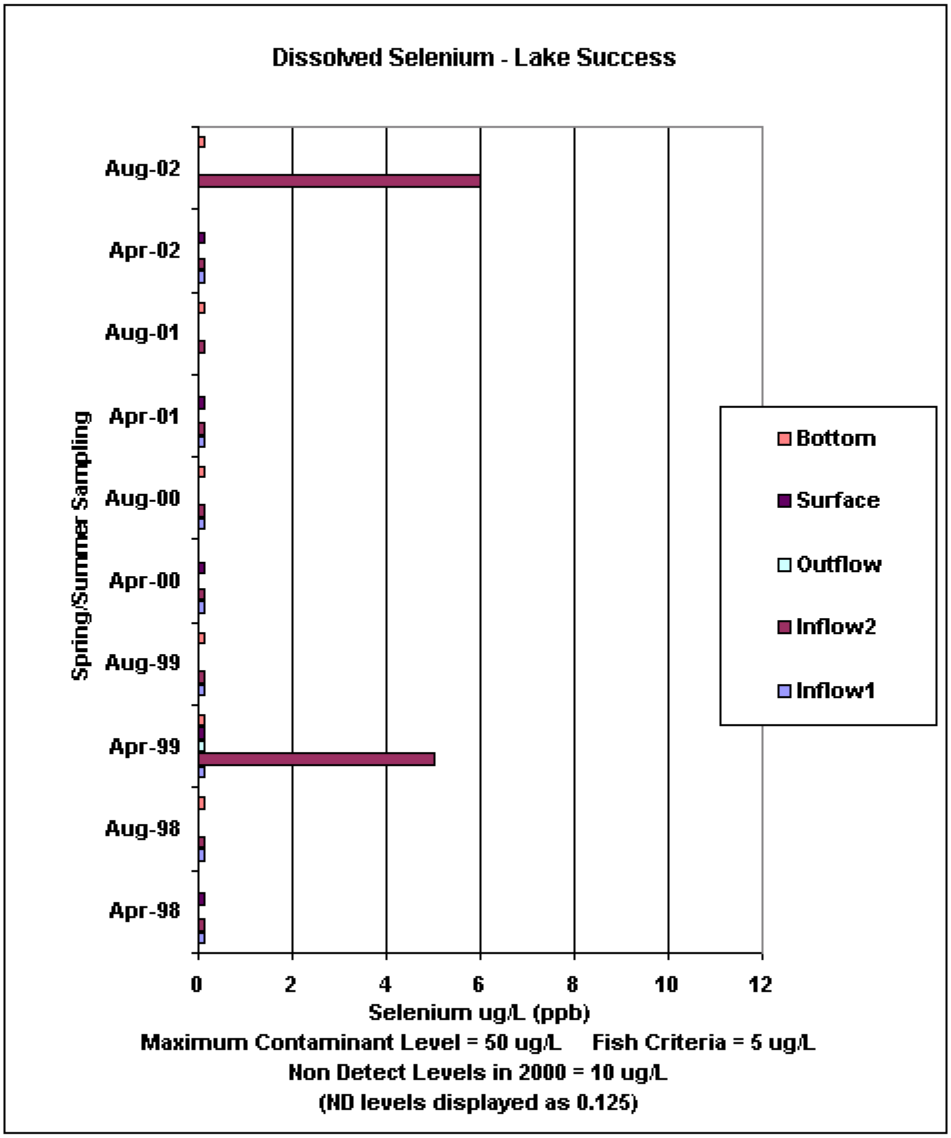
Dissolved Lead - Lake Success
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
0.5
1
1.5
2
2.5
Lead ug/L (ppb)
Maximum Contaminant Level = 15 ug/L Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L
(ND levels displayed as 0.0375)
Bottom
Surface
Outflow
Inflow2
Inflow1

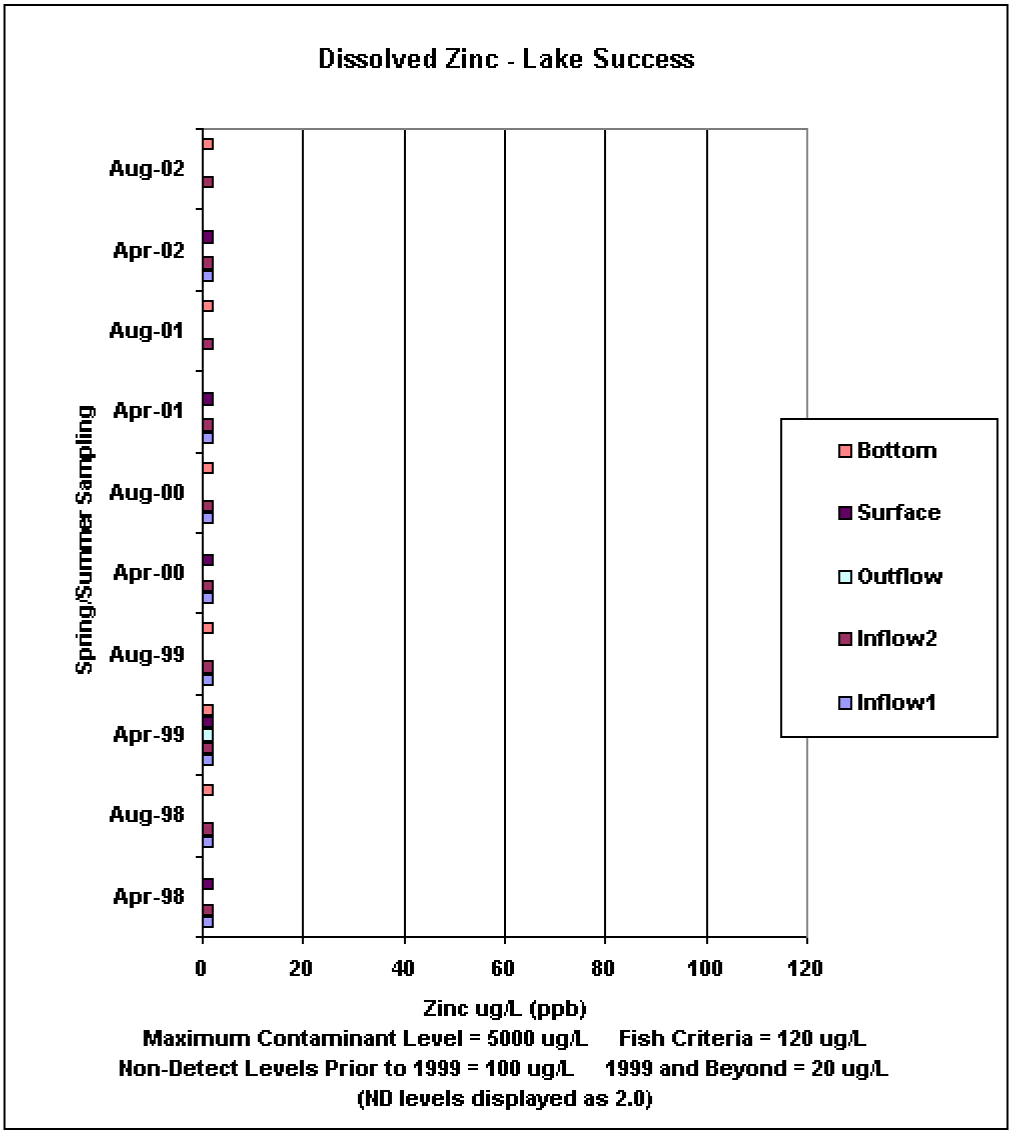


Dissolved Manganese - Lake Success
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
100
200
300
400
500
600
700
Bottom
Surface
Outflow
Inflow2
Inflow1
Manganese ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = none
Non-Detect Levels = 5 ug/L
(No modification of scale)



Dissolved Mercury - Lake Success
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Spring/Summer Sampling
0
0.05
0.1
0.15
0.2
0.25
Mercury ug/L (ppb)
Maximum Contaminant Level = 2.0 ug/L Fish Criteria = 0.77 ug/L
Non-Detect Levels For 2000 = 0.2 ug/L
Bottom
Surface
Outflow
Inflow2
Inflow1


Dissolved Selenium - Lake Success
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
2
4
6
8
10
12
Selenium ug/L (ppb)
Maximum Contaminant Level = 50 ug/L Fish Criteria = 5 ug/L
Non Detect Levels in 2000 = 10 ug/L
(ND levels displayed as 0.125)
Bottom
Surface
Outflow
Inflow2
Inflow1


Dissolved Zinc - Lake Success
Spring/Summer Sampling
Aug-02
Apr-02
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
0
20
40
60
80
100
120
Bottom
Surface
Outflow
Inflow2
Inflow1
Zinc ug/L (ppb)
Maximum Contaminant Level = 5000 ug/L Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L 1999 and Beyond = 20 ug/L
(ND levels displayed as 2.0)

Appendix E: Inorganic Sample Data

Inorganic Results (mg/L) For surface lake waters (spring)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity		60	40	50	60	30	40	70	80	20		100
Ammonia		<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Chloride		21	2	21	4	4	3	<1	6	5		4
Nitrate		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1		<0.1
Total P		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
Sulfate		5.3	2.6	4.2	8.9	2	1	8.2	9	2.1		4.7
Kjeldahl N		0.6	0.1	0.4	0.2	<0.1	0.3	0.2	0.2	0.2		<0.1
COD					<50							
Tot Solids		120	70	100	110	60	78	100	120	21		150

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	100	70	40	50	20	30	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	13	25	3	21	<1	<1	4	<1	6	4	3	2
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	
Sulfate	18	2.1	2.3	3	2.8	1.9	0.8	8.8	11	1.6	11	3.5
Kjeldahl N	<0.1	0.2	<0.1	0.3	<0.1	<0.1	0.2	0.2	0.1	0.1	0.1	<0.1
COD	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	170	130	59	110	60	60	90	110	150	30	130	90

Inorganic Results (mg/L) For surface lake waters (summer)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	140	70	40	50	50	40	70	90	80	10	80	110
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
Chloride	16	26	4	19	6	5	5	5	9	3	5	8
Nitrate	<0.1	1.5	<0.1	1.3	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1
Total P	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	16	4.1	3.6	3.5	5.9	2	0.7	7.4	14	1.6	6.4	4.4
Kjeldahl N	<0.1	2.7	<0.1	0.4	0.4	0.3	<0.1	0.2	<0.1	<0.1	0.2	0.6
COD	<50	60	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Tot Solids	200	190	50	120	98	80	80	120	120	52	100	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)												
	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	90	40		60	40	80	100	130	20	110	180
Ammonia												
Chloride	16	490	5		10	8	3	5	14	4	5	22
Nitrate												
Total P												
Ortho P												
Sulfate	16	4.5	3		9.8	3.2	<0.5	6	14	2.7	5.4	8.7
Kjeldahl N												
COD												
Tot Solids	200	1300	50		140	100	100	150	200	50	140	280

Appendix F: MTBE Table

2002 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2002 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	2		2		<2		<2		
Eastman	5				<2				
Englebright	3		3		10		10	10	
Hensley	3		3		3		3		
Isabella	<2	<2	<2	<2	<2	<2	<2	<2	
Kaweah	2		2	<2	8		6	6	
Martis Cr.	<2				<2				
Mendocino	<2				<2				
New Hogan	<2				3				
Pine Flat	<2		<2		2		2		
Sonoma		3	<2		<2		2		
Success	4		4	4	11	12	11	11	

Notes:

1. Non-Detect is indicated by "<2" since the Reporting Limit is 2 ppb or 0.002 ppm.

2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.

3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.

4. For 2002, the number of MTBE water sampling at each lake is based on last year's lab results.

5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was historically non-detectable. The 2002 results of non-detectable levels were similar except Lake Eastman and New Hogan now reported low, detectable levels of MTBE.

6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because of historically low detectable levels of MTBE.

7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because of historically higher MTBE being found. The 2002 results were similar except Isabella now reported non-detectible levels.

8. In 2001, very high MTBE levels were reported at Lake Isabella during the Spring (18 ug/L near the marina) . During Spring 2000, Lake Isabella reported 21 ug/L. The 2002 results indicate that the previous MTBE problem near the marina was not visible during the Spring 2002 sampling event, and may have been rectified.

G. Fish tissue analysis table

2002 Fish Tissue Results

The following table provides an overview of the lab results for the 2002 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conductng the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The California OEHHA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Mercury Total ppm	FDA Criteria
Black Butte	Sm M Bass	Composite (3)	6/12/02	0.24	0.26	1 ppm
Eastman	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Englebright	Note 5	N/A	N/A	N/A	N/A	
Hensley	Black Bass	Composite (3)	4/23/02	<0.10	0.72	1 ppm
Isabella	Black Bass	Composite (3)	6/4/02	0.20	0.21	1 ppm
Kaweah	Sm M Bass	Composite (3)	7/14/02	0.11	0.53	1 ppm
Martis Cr	Note 4	--------------------	-----------	----------	-----------	< Mon 00
Mendocino	Note 6	N/A	N/A	N/A	N/A	
New Hogan	Lg M Bass	Single (1)	6/3/02	<0.10	0.34	1 ppm
Pine Flat	Note 4	--------------------	-----------	----------	-----------	< Mon 01
Sonoma	Note 6	N/A	N/A	N/A	N/A	
Success	Black Bass	Composite (3)	4/15/02	<0.10	0.18	1 ppm

Notes:

9. Non-Detect is indicated by "<0.02". The lab Detection Limit for mercury is 0.02 ppm.
10. Total Mercury was reported in mg/g or ppm.
11. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.
12. The fish tissue program was terminated at Eastman and Martis Creek in 2001 and in Pine Flat in 2002 due to low total mercury results. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout). For Pine Flat total mercury was 0.21 ppm in 2000 (composite of three Sacramento Sucker fish) and 0.23 in 2001 (composite of three spotted bass).
13. Due to seasonal conditions, a fish could not be successfully collected at Lake Englebright. Another attempt will be accomplished for the 2003 report.

14. Fish were not collected at Mendocino or Sonoma due to communication difficulties.

The above 2002 total mercury results indicate only Hensley is higher than average. However, in 2001, the total mercury results were only 0.30 ppm for Hensley (small mouth bass). The 2003 fish tissue program should provide additional data. EPA fact sheet on fish advisories (EPA-823-F-99-016) indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.